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-Joshua S., Hurst, TX

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by Mike Duff

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were created to reconcile the
absurdly American priorities
of sitting high and going fast.”

—JOSH JACQUOT, “NAMING RITES”

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NHRA CHAMPIONSHIP DRAG RACING
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To: FCA US LLC, regarding its Dodge brand

Date: November 30, 2016

This letter verifies that on Monday, November 21st, 2016 at Gainesville Raceway in Gainesville, Florida, the Dodge Challenger SRT Demon ran the quarter mile in an elapsed time of 9.650 seconds at 140.09 miles per hour. Both the elapsed time and the speed on this run exceeded the limits on 2008 OEM model-year and newer production cars and therefore violate our rules. The car exceeded our limits of 9.99 seconds and 135 miles per hour. Therefore, before this car can be run again at an NHRA Member Track, it must be brought into compliance with the rules and regulations found in Section 4 of the NHRA Rulebook. If you have any questions concerning this letter or the rules in Section 4 of the NHRA Rulebook, please contact me.

Sincerely,

A handwritten signature in white ink, appearing to read "Glen Gray", is written over a dark, textured background.

Glen Gray
NHRA
Vice President, Technical Operations

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Hey, Jones: The letters section of the magazine doesn't just help us by filling pages we might otherwise have to write. It also helps the guy who writes the blurbs on the table of contents pages.

128 . *WHAT I'D DO DIFFERENTLY*

Kyle Petty.

On the Web

BMW ALPINA B5 BITURBO

A discreet M5?
[CarandDriver.com/
2018AlpinaB5](http://CarandDriver.com/2018AlpinaB5)

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Backfires: The joyful noise of the commentariat, rebutted sporadically by Ed.

GREEN MACHINE

The green Civic Si on the cover of the August 2017 issue looks like the Hulk ripped his pants and tried to hide his undercarriage.

—Lukas Lin
Anaheim Hills, CA

Kinda ugly? Against the current pantheon of ugly that includes the snowplow grille of the new Toyota Camry, the Civic Si rises to the top. Atrocious.

—Russell Buonasera
Houston, TX

Who are you calling ugly? So youze guys at *Car and Driver* put the new Civic Si on the cover, and you have the nerve to say it's "still kinda ugly."

Let me tell you something . . . nobody gets off calling dis car ugly. Protruding

taillights evoke the daring look of the luxury brands. The sides and bumpers recall the aesthetics of the new beautiful Prius Prime. Youze guys need to apologize!
—Dr. Michael Sanders
Sarasota, FL

Well, they must be doing something right; as of press time, the Civic sedan and coupe were outselling the Accord—Ed.

Hmm. The Civic Si and the new BMW 8-series concept ["Ace of an 8," August 2017] have very similar and ugly front ends, but only the Civic gets called ugly. Perhaps the color was just too much. Or is Honda trying too hard to make its offerings Gen-X compatible?

"THE CIVIC Si AND THE NEW BMW 8-SERIES CONCEPT HAVE VERY SIMILAR AND UGLY FRONT ENDS, BUT ONLY THE CIVIC GETS CALLED UGLY."



I feel a Hiku [sic] coming on.

—Brent Fetterly
Redding, ON

Don't misspell a word / Or Ed. will give you a [sic] / Now I have hiccups —Ed.

I take issue with a comment Jared Gall made regarding the 2017 Honda Civic Si in the August issue. He wrote, "It's a wild-looking thing, this Si, but it's hard to see people older than their 20s taking the look seriously."

I'm 63 years old, and guess what? I would seriously consider taking a look at the 2017 Civic Si if my old one needed replacing. Yes, I am the proud owner of a 10-year-old 2007 Si that runs as good as new. I was 53 when I bought it. I was told back then that I didn't

fit the demographic for that vehicle. But I find that my butt fits perfectly in that driver's seat to this day. I have no plans to replace it just yet. But if it ever needs replacing, I will consider buying a new one. I just wanted to burst your bubble about who would seriously consider buying one.

—Joe Rodriguez
Las Vegas, NV

How many noticed that the Civic Si has directional wheels, which are identical on both sides? On the left, they point one way, and on the right, the other way. Same with my wife's new Accord coupe. When I asked the salesman, he said he'd never noticed it. So Honda, make them nondirectional or spend the money to have the left wheels mirror the

right ones. By the way, the original Acura Legend coupe had mirror-image wheels.

—John Cuellar
Asheville, NC

I couldn't help but notice that the Civic Si's "Competitors" chart includes the Ford Focus ST, the VW GTI, and the Hyundai Elantra Sport. Having just purchased an Elantra Sport, I can confidently say that nobody in their right mind would choose the Elantra over any of those other cars. That said, the Elantra is thousands of dollars less expensive than the other three. Why not compare them to a WRX or something that people looking for cars in that price range would be more interested in?

—Rich Shriber
Provo, UT

As I read through the 2017 Civic Si road test, eyes seared like tuna steaks from that lime-green paint, I glanced toward the spider chart and immediately picked out the matching lime-green color as the Civic Si. Of course it was not, but my brain was undeterred in thinking so, even after reviewing the legend. The association was impossible to get out of my head, more so with pictures of the Civic immediately above the chart.

Graphic designer: "Okay, the article will have a garish lime-green Civic plastered over the five preceding pages plus directly above the spider chart, and the color options are blue, orange, red, and lime green. Lime green for the GTI, blue for the Civic. Natural fit."

—Jesse Severance
Marshfield, WI

The art department informs me that the road-tested vehicle always gets a blue line. I asked why, but then I was told to "shut up and get out of the art department."
There's no way I'm going in there again, Severance—Ed.

HALF-LIFE

Like the early gold prospectors annoyed by pitchblende, I had the strange experience of being annoyed at the mere mention of a vehicle in *Car and Driver* ["Atomic Prospector," August 2017]. I was so immersed in the scenery, descriptions, and story of Robinson's article, thinking of the sentiments I share with Edward Abbey and the fascinating mystery of abandoned mines, that when he would mention the Chevy Colorado ZR2 in the narrative, it was almost an inconvenience, a moment of "What's this doing here? Let's go back to the good stuff." I'm not sure if it's the kind of response you want for an article in a car magazine, but it's definitely a testament to Robinson's skill as a writer. Keep up the good work.

—Kelly Edwards
Enid, OK

Loved this article and how Robinson weaved a searcher's story with a truck searching for relevance among its full-size companions.

—Steve Sullivan
Seattle, WA

"I WAS SO IMMERSED IN THE SCENERY... THAT WHEN HE WOULD MENTION THE CHEVY COLORADO ZR2 IN THE NARRATIVE, IT WAS ALMOST AN INCONVENIENCE."



Explained: Coming to Grips

If a car posts a 0.94-g figure on a 300-foot skidpad, does that mean that it was at 0.94 g when the car lost traction and slid off the circle or does it mean something else?

—Bruce Kuipers, Riverdale, NJ

In our skidpad test, the vehicle is driven at the highest possible speed that allows us to follow the circumference of a 200- or 300-foot-diameter circle for one complete lap. It takes skill to ride the limit of adhesion, and if the vehicle loses traction and goes appreciably wide of the circle, we throw that run out. It's possible to achieve a higher peak lateral grip momentarily during initial turn-in, but our test reveals the maximum force you could expect to experience through a corner. Using either a VBox or an infrared timer, we measure how long it takes to complete the circle. The resulting time allows us to calculate the vehicle's average lateral acceleration (roadholding) over the circumference of the circle—Ed.

KEEP ROWING

I was very surprised that you folks placed the Honda Pilot last in your crossover test ["Three-Row Minivan Surrogates," August 2017]. It's a Honda! Parents buy these SUVs not because of saddle-brown interiors but because they are people movers. How can you rate the CX-9 first when you had difficulty getting in the second and third rows? On a road trip from Montreal to the 2017 Daytona 500, I noticed that Honda Pilots and Toyota Highlanders are the people's choice by far in this class.

—Don Wood
Montreal, QC

You probably drove by a lot of parent-friendly McDonald's PlayPlaces, too. Doesn't mean it's something you want in a restaurant, even a family one—Ed.

A scant 15 horsepower and 11 pound-feet of torque are the differences between an "anemic" V-6 [in the Durango] and one that's "roaring" [in the Acadia]? I think it's the Dodge Durango's 740 additional pounds of lard that have your attention, not its engine. We're truly drunk on power when a 295-hp V-6 is anemic.

—Rob Gross
Summerville, SC
Horsepower and torque make no sound. Kind of like my cousin Tom—Ed.

How could you not include the Toyota Highlander in this compare?

—John Dan
Salinas, CA

Easy. We didn't ask for one—Ed.

This is what happens when car guys review SUVs. Nobody buys three-row SUVs

because they're good on twisty bits—that's what Mustangs and Miatas are for. They buy them to carry people and stuff and tow things. Based on your figures, the VW Atlas or the Durango should have won, although apparently you tested a nearly \$50K Atlas that didn't have a tow package.

—Brooks Fenton
Oakley, CA

We're just supposed to accept that three-row SUVs shouldn't have personality?—Ed.

I noticed that the Atlas received no points for towing ability. The truth is, the model you tested has a standard towing capacity of 5000 pounds and it should have received four points for that versus the zero it got based on the other vehicles. Schools have changed the way math is taught these



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days, but doing it the old-fashioned way earns the Atlas four more points, which puts it in what place? After the recount, do we have a new winner declared?

—James R. Dartt
Saunderstown, RI

We score all comparisons based on the vehicles we tested. Our Atlas had no electrical connector for a trailer, neutering its claimed towing ability—Ed.

Regarding your “summer vacation” with five three-row SUVs: Was the lake still covered with ice? When in summer do the trees in northern Michigan get leaves?

—John Duryee
Cranford, NJ

At about the same time of year that the burning-tire odor at exit 13A of the New Jersey Turnpike starts smelling like rotten eggs—Ed.

You spent over \$49,000 on a Dodge Durango and did not get the optional V-8? And you expect us to look to you for car-buying advice?

—Nick Apruzzi
Aberdeen, NJ

Settle down, Jersey—Ed.

Having owned five VWs and two Mazdas in the past, I knew I would buy either the Atlas or the CX-9. But I made the decision to buy a Mazda CX-9 AWD two weeks before my local VW dealer even got its first Atlas in stock. I have no doubt that I made the right choice. I wanted a touring car that was nimble, agile,

and quiet (as you described in your article) to take on long trips with my wife. Can't wait for your article on the long-term test of your 2016 CX-9.

—Gary Nestor
Southgate, MI

Your statement about the Atlas in the three-row SUV comparo was spot on: “We waited 10 years for this?” Other than the obligatory LED running lamps, there is nothing inspired enough in the design of the Atlas to suggest it was executed during this decade. Did someone in Wolfsburg find the blueprints for this under a stack of Winterkorn's tax returns from 2007?

—Shredd
New York, NY

TIRED OUT

Great tire article [“Gumshoes,” August 2017]. The test was well done and the analysis was informative, but why wasn't there a Bridgestone option tested? Seems incomplete without.

—Dave

Anchorage, AK

Bridgestone's entrant in this category, the Potenza S-04 Pole Position, hasn't been updated since it earned second in our 2012 performance-tire test—Ed.

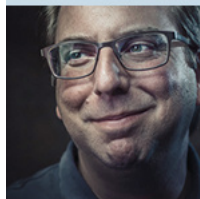
The subhead on page 068 of the August issue says “A Congressional-Grade Independent Investigation into Five Sticky Summer-Performance Tires.” In view of the almost total lack of constructive



Editor's Letter:

Last year, I got a call from a strange outer-borough number. The voice on the line was immediately recognizable as America's foremost lateral thinker, Malcolm Gladwell.

Turns out, he's a *C/D* reader. He remembered the testing we'd done on unintended acceleration and wanted to do a piece for his *Revisionist History* podcast on why people are liable to press the wrong pedal in panic situations. I guess he liked working with us, because he agreed to edit the bulk of this issue, the 31 pages we've devoted to investigating the driverless car [beginning on page 058].



The driverless car has beguiled the sages and confounded the media mandarins for five years. The tech is here, right? Lane keeping, adaptive cruise control, automated emergency braking, sentient steering—that's all front-loaded into most every highly optioned new car on the road. So the fully automated car must be right around the corner, no? It's actually here someone told me because they read something about Uber and Volvo in Pittsburgh, driving people around in robo-

cars. Except, maybe that's wrong.

Indeed, the myths surrounding the automated car abound, reinforced by a well-meaning press that has absolutely zero idea how the car business works, disclaimingly ignorant of the stock-driving power of overhyped new technology.

The myths are these: 1) **The computer-driven car is already here.** I'm sure a lot of Uber riders were disappointed to get into those Volvos in Pittsburgh only to find an actual human at the wheel. But the fully automated car's delivery date keeps extending into the horizon, much like the obituary of the internal-combustion engine. 2) **Okay, so maybe they're not here yet, but when they get here, they'll definitely drive you around all the time.** To the contrary, there are various levels of automation, and it remains unclear whether the kind of semi-automation we have now—be it Auto-pilot or Super Cruise or Traffic Jam Pilot—will necessarily lead in an uninterrupted way to full automation. Our editorial deep dive asserts that it's probably more realistic to think in terms of two parallel paths, with the driver aids in today's upscale cars growing in sophistication, and the separate, fully automated technology relegated to domained areas due to the need for a predictable and matrixed environment where everything is talking to everything else—cars, pedestrians, road signs. 3) To the prior point, many think that **computer-driven cars will eliminate the need for privately owned, human-driven cars.** Imagine the requirements of the suburban parent, whose three kids are in five different activities, with last-minute changes to plans and routes, a galley's worth of equipment at the ready for any kid-related event that might crop up. Can this person truly be served by the shared CitiCar, as depersonalized and germ-carrying as a rented tux? Doubtful. My view is that fully automated machines will be the small buses of the future, not the cars. Cars will be the things you drive.

There is so much we take for granted in our driving experience—the joy of controlling a car, the freedom it enables, the way it preserves individuality while masking identity. All that is wrapped up in this very complicated and unclear transition to this already not-so-new technology. To date, no one has looked at the transition in its entirety, taking into account all the regulatory, technical, and social challenges still to overcome. Who better than Gladwell to help us do that?

—Eddie Alterman



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*306 hp @ 6500 rpm (SAE net). Civic Type R Touring Shown. ©2017 American Honda Motor Co., Inc.

Letter of the Month:

—
“On our summer vacation, we took a bunch of three-row SUVs to camp. You guys want to see the slideshow?”
No.

—Joseph Lohnes
Albuquerque, NM

accomplishments and dubious credibility (to be kind) of the current Congress, I suggest that you urgently seek a different and higher standard by which to indicate the quality of your work.

—Robert Nichols
Rancho Santa Fe, CA

BITCHIN' CAMARO

In your August 2017 long-term test of the 2016 Chevy Camaro, you state that you paid for oil changes that should have been free. You also mention that the same thing happened with your long-term Corvette. Why did GM not cover these under its maintenance plan?

—Rod O'Byrne
Regina, SK

Our road warriors were a little too eager to whip out the corporate Amex, and the dealer was happy to accept it—Ed.

Interesting how a brand-new Camaro SS can consume what appears to be quite a bit of oil—five addi-

tional quarts, or one quart per 4700 miles. This seems excessive, especially for a brand-new car, and Chevrolet says this is normal. How is this normal? If it isn't leaking or burning, then where is it going? It certainly would make someone think twice about buying a car with an LT1.

—Andrew J. Sultan
Austin, TX

The Camaro quite likely burned the oil. One quart per 4700 miles is annoying, but it's not considered excessive. One quart or more per 1000 miles is generally the rate that is considered excessive—Ed.

GUANPANAMERA

Quiroga's article in the August C/D [“The Lapper Gets Dapper”] was interesting, but he needs edification regarding the Porsche Panamera Turbo: Every generation of this “car” is hideous. A 4600-pound hatchback with 550 horsepower and a base price over \$150,000? Heinous. But I'll give it credit for this: Like Los Angeles, the Panamera doesn't deny being vainglorious, and it's pretty good at what it does best—entertain. Actually, it might even be moderately cool if mated to the six-speed manual that Porsche just put in the 2018 911 GT3. Might be a tough sell in the City of Angels, though.

—Jordan Garrick
Carmel, CA

GEOMETRY CLASS

Someone needs to tell Jens Meiners to

retake geometry class [“Ace of an 8,” August 2017]. The description of the 8-series concept's “trapezoidal exhaust finishers” is just plain false. Anyone with the wits to use Google would be reminded that trapezoids have one pair of parallel sides, which the 8-series' tailpipes are not. Those are just grotesque quadrilaterals.

—John Park
Phoenix, AZ

Great. Now Meiners is in the corner rolled up into an icosahedron. Happy, Park?—Ed.

GOO-GOO CLUSTERS

I got my August issue with a sample of 303 Protectant. Unfortunately, the sample's package didn't survive the trip, and it saturated the back third of my issue. According to the propaganda, it'll now be protected from UV rays and will help repel dust, lint, and stains all while remaining dry to the touch. No, I don't want a replacement, but please be careful with what you try to send us.

—Richard Brant
San Antonio, TX

That magazine will last forever—Ed.

LANDFILL

In your August 2017 issue, the Backfires section spans six pages. Are you just printing every letter you get so you can write less?

—D.P. Jones
Grand Prairie, TX

Jones, I think you just answered your own question—Ed. ■



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DRIVE A WEDGE

BMW'S CONCEPT Z4
PLAYS ALL THE ANGLES.

by James Tate

001



THE THIRD ITERATION of BMW's Z4 roadster is just around the corner, and it represents a new approach to the way Werke does business. This roadster has been co-developed with Toyota, which will market its version of the car as the reborn Supra. The Concept Z4 also indicates a stylistic departure from every past generation of the company's smallish drop-top, with the long-hood proportions and sweeping body lines of the outgoing car reshuffled. Heck, the concept even reinterprets BMW's familiar double headlights. Together with the recent 8-series preview, this Z4 points clearly to a new direction for BMW's design language, one that emphasizes angles over curves. Departure though it may be, the Concept Z4 is a looker.

001

Designers drew inspiration for the grille mesh from the 328 Mille Miglia. The relatively high-set headlights pay homage to the Z8.



▼ **STYLING**

Trading the flowing, slightly bulbous lines of its predecessor for an aggressive chiseling throughout, the Concept Z4 looks the beans in its Energetic Orange paint. A retro, shark-nose front end juts forward even as the rest of the car seems canted steeply backward. Below the grille, the lower apron is a caricature of what you find on current M products. Though it's unlikely that the production car will see the cartoonishly drawn lines of the concept's lower bumper, they work well here, supporting the overbite of the grille and cutting any would-be blockiness out of the Concept Z4's face.

The intersection of the clamshell hood and the fender draws focus to the trick in



“THE TURBOCHARGED FUTURE IS ALREADY HERE, SO IT’S SAFE TO SAY THAT IF THERE’S AN M VERSION, IT’LL FEATURE A HIGHER-OUTPUT STRAIGHT-SIX, LIKELY A DETUNED VERSION OF THE 425-HP UNIT IN TODAY’S M3 AND M4.”

001



the car’s design: Though the Concept Z4 appears to be entirely angular, there isn’t a flat spot anywhere or a line that doesn’t have a subtle curve. Big vents behind the front wheels direct air into scooped-out door panels that bear more than a passing resemblance to those on a Corvette. The distinctive, rounded back end wraps up nicely with now-familiar hockey-stick taillights that crib heavily from the i8. Below them, exaggerated versions of BMW’s trademark air ventricles in each corner help cut the visual bulk of the rear bumper.

▼ POWERTRAIN

There’s no official word yet on which engines we can expect to power the production Z4, but a test mule was spotted with a spec sheet taped to the dashboard. It sug-

3804

The folding-hardtop Z4 was never able to replicate the success of its cloth-capped forebear. While the softtop car surpassed 20,000 sales in 2003, the outgoing (E89) generation had its best year in 2010, when sales topped out at just 3804.

gested that the rear-drive Z4 will offer the turbocharged 2.0-liter four-cylinder of its predecessor. Bet on a turbocharged 3.0-liter inline-six being the optional engine. That same set of spy shots showed a six-speed manual transmission, and we see no reason why BMW wouldn’t hold on to the excellent ZF-sourced eight-speed as the automatic choice. The turbocharged future is already here, so it’s safe to say that if there’s an M version, it’ll feature a higher-output straight-six, likely a detuned version of the 425-hp unit in today’s M3 and M4. While BMW’s U.S. operations have gone gaga for hybrids, we expect the Z4’s limited sales potential to keep such a powertrain off the roadster’s options list.

001

Fairings are a flashy way to incorporate rollover protection into a concept’s styling, but they can obstruct top movement. We expect them to disappear for production.

002

That hexagonal pattern on the driver’s inner bolster is laser-cut, which means it won’t move beyond the concept phase. And look closely at the bottom spoke on the steering wheel: That’s a lap timer. Cool use of real estate, but a lap timer that is often upside down or sideways is of limited use.



▼ CHASSIS

Though this concept-car body could well be fixed atop a chassis made of pretzels and gumdrops, the production car's underpinnings will be shared with Toyota in the companies' joint sports-car venture. BMW makes note of the more central location of the cockpit in relation to the rest of the chassis—the key change to the Z4's proportions. Without question, the concept divides the visual bulk more evenly than any previous Z, though its wheelbase is just 1.1 inches shorter than that of last year's Z4. At 170.0 inches, the concept is 3.1 inches longer than the outgoing car. Its 76.2-inch width—an increase of 5.7—is unlikely to carry over into production but certainly helps the concept's dramatic proportions. The show car sports 20-inch wheels and Michelin Pilot Sport Cup 2 rubber, but it's safe to assume that production models will start with 18-inchers and all-season tires. Spy shots reveal that the production car will return to the first-gen's softtop, as opposed to the outgoing Z4's folding metal lid, thereby saving weight, space, complication, and cost.

003

Angling the infotainment screen toward the driver seems far less distracting than what Audi did with the TT's, which was to remove it altogether and integrate its functions into the instrument panel.

▲ INTERIOR

With the half-black, half-orange interior, BMW's designers wanted to draw attention to the driver-centric cockpit layout, the orange pop on the passenger's side blending in with the exterior panels. If you squint hard enough, you can almost see a leather-tonneaued single-seat cockpit, a modern take on an early Jaguar. Almost.

The driver-focused theme continues in the instrument cluster and center stack, which are oriented dramatically toward the driver. Both are set at nearly the same height, keeping the important information close to eye level. The instrument cluster itself is a TFT display that houses a speedometer and a counterclockwise tachometer, à la Aston Martin. Sadly, the deep-dish steering wheel will definitely not make it to production, nor do we expect the production car's shifter will block the driver's access to the iDrive controller.

The Z4 goes on sale next year as a 2019 model. You'd be wise to expect the production car to look an awful lot like the concept. Be excited about that.



SPOOL SAMPLE

MULTIMATIC'S SPOOL-VALVE DAMPER REFINES SUSPENSION TUNING. *by K.C. Colwell*

SCANT BITS OF TECHNOLOGY trickle down from racing to street cars anymore. Multimatic's Dynamic Suspensions Spool Valve dampers are one of the few. The Canadian supplier's dampers first appeared in the 2002 CART series, then migrated to Formula 1, and now populate about half the Le Mans starting grid. Aston Martin's limited-edition One-77 was the first production car fitted with DSSV dampers and Chevrolet's fifth-generation Camaro Z/28 followed in 2014. With their blend of street comfort and track-ready attitude, DSSV dampers are like shampoo and conditioner in one. Currently you can find them in the Ford GT, the Mercedes-AMG GT, and the Chevy Camaro ZL1 1LE and Colorado ZR2. Their simplicity is a thing of engineering beauty, so we uglified one up by cutting it in half with a band saw.

Conventional dampers set compression and rebound forces by controlling the flow of fluid through orifices with stacks of flexible shims. Spool valves (001) dynamically vary damping force by controlling fluid flow through precisely shaped ports using a spring-loaded shuttle. Each DSSV damper contains two spool valves, one for compression and one for rebound.

WINDOWS: There are six ports, or windows (002), on each street-car valve. Racing applications get fewer. The shape of the port helps define the damper's baseline force-velocity curve—how much damping force is generated based on the

vertical speed of wheel movements. The narrow end of each opening establishes the low-speed damping. Multimatic has eight window shapes in production, but the possibilities are nearly infinite. The window shape is one of the first things locked in the tuning process. When cutting the ports into the spool valves, Multimatic leaves the edges rough. The resulting turbulent flow smooths out the damper's action.

SHUTTLE: The shuttle (003) is the metaphorical shutter that opens and closes the window to fluid flow. It looks like a piston with holes in its crown and is supported by a spring that compresses under the force of vertical wheel movement. The faster the movement, the more the window opens to let the damper's fluid pass through the valve. It is both passive and elegant. The initial position of the shuttle relative to the window is also a tunable element.

PIN: The force that moves the shuttle acts through a cuplike pin (004) in the center of the shuttle. A larger-diameter pin reduces the gradient of the force-velocity curve.

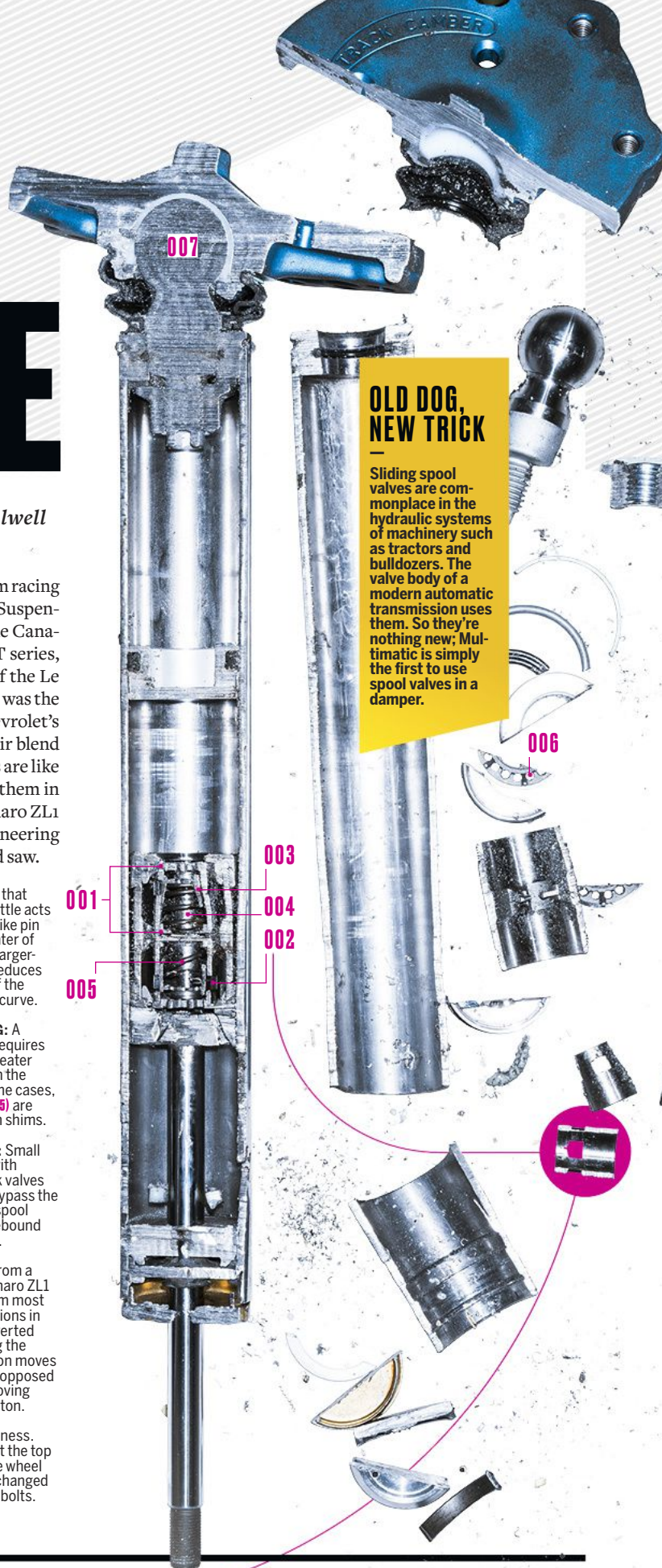
VALVE SPRING: A stiffer spring requires more force (greater speed) to open the window. In some cases, the springs (005) are preloaded with shims.

BLEED PATHS: Small orifices (006) with one-way check valves allow fluid to bypass the compression spool valve during rebound and vice versa.

This damper from a Chevrolet Camaro ZL1 1LE differs from most DSSV applications in that it is an inverted strut, meaning the damper's piston moves in the body as opposed to the body moving around the piston. This results in increased stiffness. The ball joint at the top (007) allows the wheel camber to be changed with just a few bolts.

OLD DOG, NEW TRICK

Sliding spool valves are commonplace in the hydraulic systems of machinery such as tractors and bulldozers. The valve body of a modern automatic transmission uses them. So they're nothing new; Multimatic is simply the first to use spool valves in a damper.





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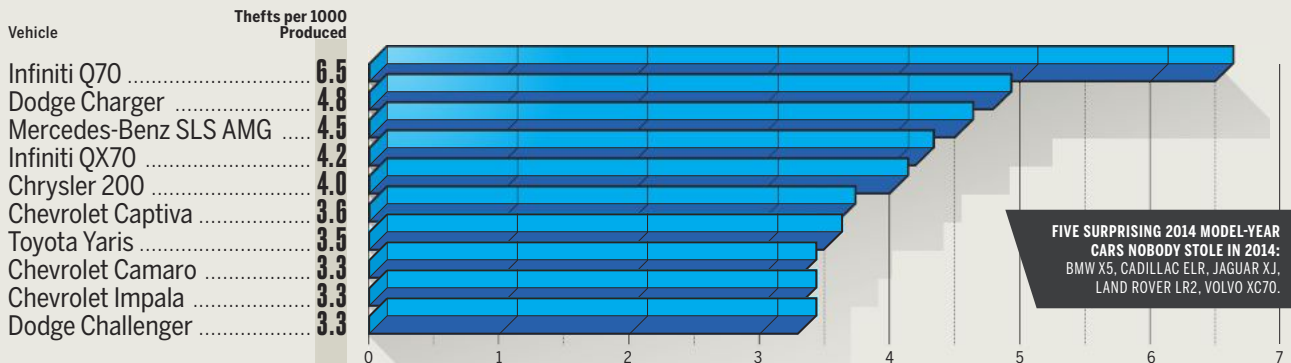


HOT CARS

NEW CARS ARE HARDER TO STEAL, BUT IT HAPPENS. A LOT. *by Clifford Atiyeh*

THINK THAT BLINKING RED LIGHT ON YOUR DASH doesn't do a damned thing? Anti-theft measures on modern cars have prevented millions of hot-wiring, steering-lock-snapping thefts over the last two decades. Even as our swelling population registers a record number of light vehicles, people can't steal them like it's 1991, when vehicle thefts peaked at nearly 1.7 million. Heck, they don't even steal them like it's 2005, when the rate of motor-vehicle thefts was 61 percent higher than it was in 2014. (The data here is compiled annually by the National Highway Traffic Safety Administration. Since it's a government agency, NHTSA runs a little slow; 2014 is the most recent year for which it has analyzed data.)

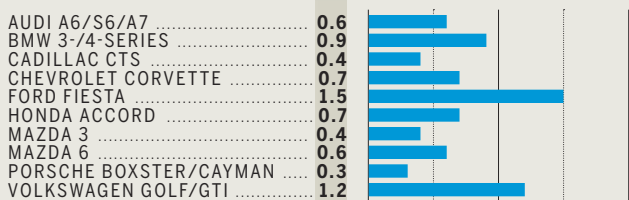
But determined thieves still prey on late-model cars and even brand-new ones. NHTSA ranks the most frequently reported stolen vehicles of each model year in relation to their total production in that year. Across the fleet, the average was 1.2 vehicles stolen per 1000 produced in 2014. But the theft rate was highest for these:



FIVE SURPRISING 2014 MODEL-YEAR CARS NOBODY STOLE IN 2014:
BMW X5, CADILLAC ELR, JAGUAR XJ, LAND ROVER LR2, VOLVO XC70.

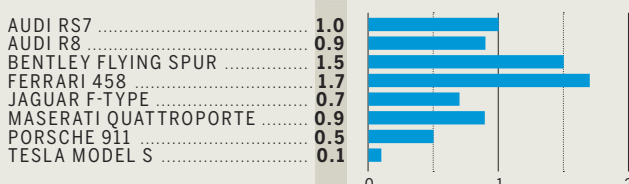
WE SAID "BEST"

We already know that a spot on our 10Best list doesn't necessarily make a car popular with buyers, but neither does it make a car popular with thieves, apparently. 2014's 10Best winners were appropriated thusly:



BOOSTER FODDER

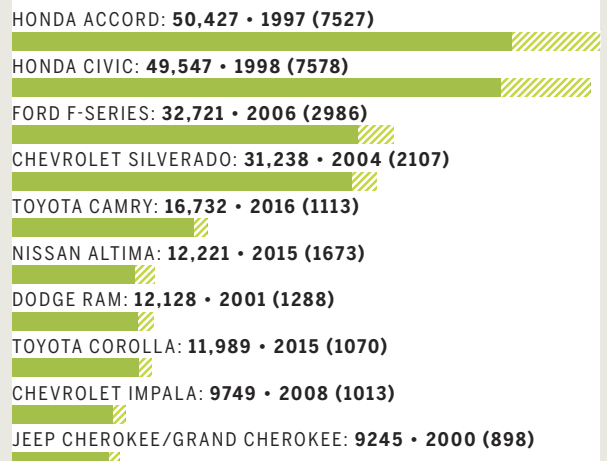
Those high-visibility cars that make for such beautiful posters tend to be the same vehicles thieves shun. Not one new Aston Martin, Bugatti, Dodge Viper, Lamborghini, McLaren, or Nissan GT-R was stolen in 2014, nor was any Ferrari other than two 458s. But criminals made off with a few of these:



GOLDEN OLDIES

Using the same FBI data set as NHTSA—only two years newer, since it's not a plodding government agency—the National Insurance Crime Bureau counts thefts for all model years, breaking out the one most popular with thieves. If you own an old Accord, look out: Thieves prefer the 1997 model 15 to 1 over the 2016. Perhaps coincidentally, 1997 is the last year Accord keys didn't have some sort of chip in them.

Car: Number Stolen in 2016 • Model Year Most Stolen



BILLIONS LOST
VEHICLES STOLEN IN 2014 TOTALED MORE THAN \$4.5 BILLION, WITH AN AVERAGE VALUE OF \$6537. RECOVERED ONES TOTALED JUST \$2.2 BILLION.

GARMIN BE GONE
IN 2014, THERE WERE 1.2 MILLION REPORTS OF STUFF STOLEN FROM CARS' INTERIORS, WITH AN AVERAGE VALUE OF \$835.

TRICKLE DOWN
AN ESTIMATED 689,527 VEHICLES WERE STOLEN IN 2014, A DECREASE OF 1 PERCENT FROM 2013. BUT COMPARED WITH 2005, IT'S DOWN A WHOPPING 44 PERCENT.

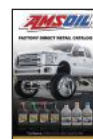


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Motorin'

CURRENT AFFAIRS

FORMULA E IS POISED TO BE THE INDUSTRY'S NEXT HOT TEST BED. by Austin Lindberg

FORMULA E, THE ELECTRIC formula-car series, seemed like a doomed political obligation when it made its debut in 2014. But its fourth season is set to kick off in December in Hong Kong, and in its first three seasons, Formula E attracted major automakers Audi, Jaguar, and Renault. In July alone, three more announced plans to join, and Audi formalized its intent to up its involvement, going from a partnership with one of the original teams to fielding a factory entry this season. Doomed? Hardly.

BMW will contest the 2018–2019 season, with Mercedes-Benz and Porsche following a year later. Mercedes will be supplementing its effort in Formula 1, but Porsche is leaving the hybrid-racing program that gave it three consecutive Le Mans wins to prioritize Formula E.

"There is a big groundswell of movement into [EV] investment," says three-time Le Mans winner Allan McNish, who heads Audi's Formula E operation. "All of the brains that have been so dominant with other technologies

BANNED TOGETHER

ONE REASON FOR THE HEAVY GERMAN PRESENCE IN FORMULA E IS THAT THE COUNTRY'S LEGISLATIVE BODY PROPOSED BANNING INTERNAL-COMBUSTION ENGINES IN NEW VEHICLES BY 2030. DESPITE GERMANY'S TRANSPORT MINISTER CALLING THE PROPOSAL "UTTER NONSENSE" AND "TOTALLY UNREALISTIC," THE WRITING SEEMS TO BE ON THE WALL IN BERLIN: THE FUTURE IS ELECTRIC—OR AT LEAST LESS DEPENDENT ON FOSSIL FUEL.

are now focused on this." He expects the adulation and shame that are heaped upon the paddock each race weekend to force development forward much quicker than would a standard road-car program.

A spec chassis and battery currently limit innovation to the motor and its controls. According to McNish, Audi saw nearly an 8 percent increase in efficiency between seasons two and three without making any major hardware changes; it merely applied the lessons it learned after mining a season's worth of data. The BMW works team hasn't yet turned a lap in competition but already expects its powertrain to weigh 50 percent less than what drives the i3 while offering 50 percent more performance and efficiency. The company says that the tech driving such improvements could reach mass production in five to ten years.

A lessening of regulations should spur further development. Beginning in 2018, McLaren will replace Williams as Formula E's battery supplier. Its units nearly double the capacity of the original, eliminating the need for car swaps mid-race. And after McLaren's two-year contract expires, it's expected that entrants will be allowed to develop and supply batteries of their own.

With increasing pressure on automakers to grow their EV programs, could Formula E become the industry's cutting edge of R&D? "It's not going to replace Formula 1 or the World Endurance Championship, but it's got its own niche, just like electric [road] cars," McNish says. "Not everybody is going to be driving an electric car in 2025, but many will." And those buyers will have a bit of the prestige and glamour of Formula racing beneath their feet.



SHOCKING GOOD LOOKS

Formula E's race cars are set to get their first major upgrade for the 2018–2019 season. Spark Racing Technologies, supplier of the current chassis, released a handful of concept renderings earlier this year. The new race car won't look exactly like this, but it could get a lot uglier and still look fantastic.

PHOTOGRAPHY BY GETTY IMAGES; JOHN LAMPARSKI; LAT IMAGES; KER ROBERTSON; BRYAN BEDDER

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DODGE VIPER

TERROR INDUCER AND RACE-TRACK ANNIHILATOR, RIP.

by Josh Jacquot

DODGE VIPER, ALSO KNOWN AS SRT Viper, Spinning Cobra, and—among more colorful commentators—the Dutch Oven Kit Car, lost its battle with popularity and cost on August 31. It was 25. It is survived by its brothers from Gehenna, Hellcat and Demon, and was preceded in death by its cousins in obsolescence, Plymouth Prowler and Chrysler Crossfire. Though the curtains are certainly final this time, Viper endured a two-year coma between 2010 and 2012, at which point its 10-chamber, 8.4-liter heart was defibrillated with Italian cash for a final five-year run of glory.

Even from its 400-hp beginning, Viper moved with purpose—defining itself with spleen-crushing mechanical grip and driving its point home with big-cubic-inch clarity. It was always that kind of car, razing the hype that makes up car launches and media campaigns and boiling itself down to one singular, monastic purpose: going real damned fast. François Castaing, Chrysler's vice president of vehicle engineering in 1990, told us then: "If everybody liked it, we wouldn't be pushing far enough."

It was an ethos that stuck for life. Though swathed in nappa leather and offering such noble stabs at modernity as a Wi-Fi hotspot, Viper's most recent iteration remained stiff, loud, and hot. And for most fans, its allure lay in that rawness. Any effort to temper



GENETIC MODIFICATION

During its 25-year run, Viper evolved through five generations encompassing about 31,000 cars. Coupe and roadster styles came and went, but Viper was always powered by a pushrod V-10 and an up-yours attitude.



1992-1995

In 1992 (same as today), there is nothing else like it. Viper makes its debut with 400 horsepower, 8.0 liters, a flimsy canvas top, and no exterior door handles or side windows. It is basically a \$50,000 motorcycle.



1996-2002

Dodge adds the 450-hp GTS coupe for Viper's second generation beginning in 1996, which allows all 10 cylinders to be heard in stereo for the first time thanks to a rear-exit exhaust.



2003-2006

For 2003, displacement increases to 8.3 liters, output jumps to 500 horsepower (510 after a new rating process is implemented), and the side pipes return. Available only as a roadster until the 2006 model year.



2008-2010

Another displacement increase—to 8.4 liters—and a power bump raises output to 600 horsepower. The Hard Core package exorcises A/C, the audio system, all hope of comfort, and your sanity.



2013-2017

Further breathing refinements release even more power, culminating in 645 horsepower by the 2015 model year. Faster than ever, Viper will kick your ass. Come prepared.



GRASPING THE OLIVE BRANCH

Viper was easy to dismiss because it required the kind of commitment most people wouldn't make. My first Viper drive came in 2002, and for 13 years, I largely dismissed the coupe as a car that tipped the risk/reward scale in the wrong direction. But in the fall of 2015, I spent two days with Viper at Mazda Raceway Laguna Seca, redressing our differences. It wasn't easy. For a day and a half, I adjusted tire pressures and my driving style. I made peace with Viper's uneasiness under braking and got comfortable with small slip angles exiting Turn 11. And then it happened. With two sessions to go, I found myself in an honest fight with a 911 GT3, and suddenly I was confident: I committed to braking late and throttling early, began using all the track on Rainey Curve, and held it flat through Turn 2. The battle was a draw, but the enlightenment was real. Viper was capable. It was seriously fast when tamed, and it made me earn it. Which I completely respect. —JJ

DEVELOPMENT TORTURE

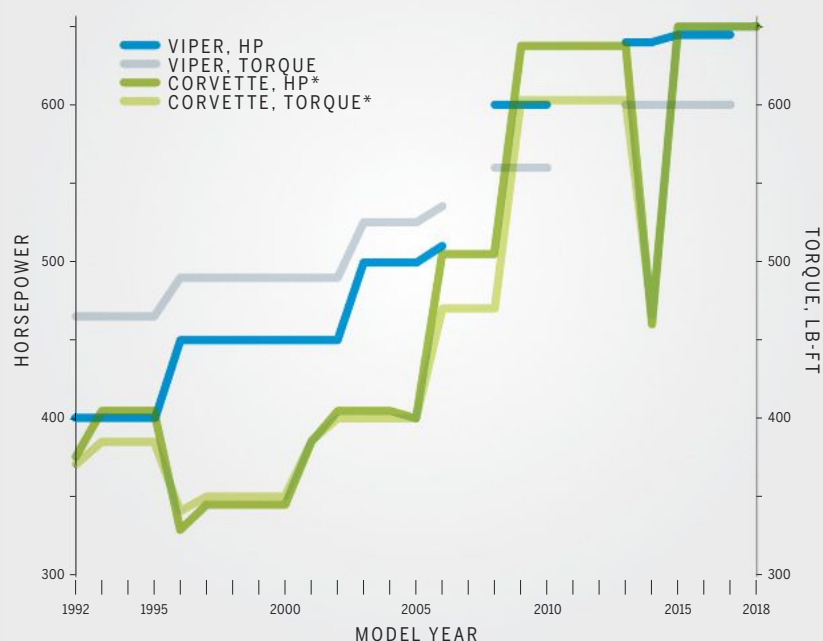
At its 2012 relaunch, Viper's V-10 received a new lightweight aluminum flywheel to improve response. Before the flywheel could reach production, though, powertrain engineers had to ensure that it passed durability testing. What's that involve? With the parking brake engaged, the tester selects sixth gear and revs the engine to 4000 rpm. The clutch is released as the driver mashes the throttle. He then repeats this. Eighty times. We're told it gets pretty smoky.

the car's spirit was viewed as emasculation rather than distillation. So focused were its creators that they proceeded, with obdurate conceit, to make it ever stiffer—even as its most obvious and equally capable competitor, Chevy Corvette, became more livable. Said Erich Heuschele, manager of SRT dynamics engineering, shortly after Viper's 2012 relaunch: "Our owners want an uncompromised track car."

And that, most certainly, is what they got. Viper proudly denied itself the favor of anti-lock brakes until the 2001 model year. Dodge finally added stability control in late 2012, the same year the technology became federally mandated. But even with electronics, Viper's brutal honesty wasn't for everyone. When pushed, it responded with an animated interest in both breaking track records and terrifying its occupants, not necessarily in that order. It remains the fastest American car we've ever lapped at Virginia International Raceway, the ACR version besting the current Corvette Z06 at Lightning Lap by 0.4 second while holding the fourth-quickest lap we've ever driven around the Grand West Course. That's not to say it dominated our scorecards with much frequency. Eleven C/D comparison tests resulted in only one victory—against a motorcycle.

Like most machines that start life without windows and finish with 645 horsepower, Viper wasn't for novices. To its end it remained a caricature—the attitude of Wyatt Earp coupled to the legs, lungs, and modesty of Usain Bolt. But beneath it all was something very American; it was a striking, purposeful, highly focused machine. Lack of subtlety was its currency and will remain its legacy. Viper was an exotic hand-built in Detroit, and its loss damages America's status as a supercar superpower. That we will miss.

VIPER VS. CORVETTE: THE POWER STORY



*Data represents the most powerful engine available for each model year.

I was once assigned to drive an 8.2-foot-long Smart Fortwo—about the size of a poufy sectional sofa—to a U.S. destination where the car was least likely ever to have been seen. Daimler AG nixed Nome, Alaska, saying something

about no service and cloven-hoofed Smart-mauling impediments. So I opted for the Oklahoma Panhandle, ground zero for ground, by which I mean the Dirty Thirties Dust Bowl. When I arrived, the Panhandlers, once known as “pumpkin rollers,” were kind to me, apart from mocking a car that nearly lost a collision with one of their tumbleweeds. Forgive me, but the Okies all seemed to be awaiting the arrival of Nikita Khrushchev and the Hula-Hoop. So when I rolled through Slapout, Oklahoma, the Smart drew two of the town’s eight people into the street, where they emitted wet pig snorts, not to mention one cowboy who removed his hat to beat against his thigh, as if extinguishing a fire.

Since 2008, according to *Automotive News*, the Daimler subsidiary has unleashed more than 2 million of the things. Well, not unleashed. More like “set free to meander in free-range meadows.” In Smart’s first year in America, 24,662 were sold—hot damn—but the number dwindled to just 6211 in 2016.



MAN MEETS MACHINE. MACHINE MEETS WEED. WEED EMERGES VICTORIOUS.



Was the Smart smart? Probably not, considering the brand recently opted to sell only battery-powered cars in North America. A Fortwo electric coupe now starts at \$24,550. That’s \$9150 dearer than the outgoing entry-model gas coupe, which was already selling like Monégasque foie gras at McDonald’s.

During the Smart’s near-10-year odyssey here, it was too often compared with BMW’s Mini, whose volumes remain roughly double the Smart’s. To me, that’s like comparing a hockey puck to a football. The Smart more closely resembles, I dunno, maybe Mitsubishi’s i-MiEV and Fiat’s 500, both also selling in what amounts to a glacial-blue trickle. The Smart has always been something of a novelty—think here of, say, the passenger-pigeon Plymouth Prowler, a hot rod wearing culottes. The Smart was best deployed as a South Beach errand hopper or as a dinghy towed behind a fat American tenement-on-wheels RV. It makes me smile that Oklahoma eventually boasted two Smart stores—one in Oklahoma City and one in Tulsa—though they’ve both now dropped the brand like a hot poufy sofa.

I spent 3000 miles driving a Smart, and I can tell you that, once you’re settled behind the wheel, the expansive forward sightlines make you think you’re operating something easily as large as a Mini, even

though the driver can (as I did) reach around to touch the backlight. I had that same larger-than-it-is sensation testing a Scion iQ, in which I could reach the fuel-filler door from the driver’s seat. Of course, U.S. buyers judged the iQ’s IQ to be several points aft of a baby stoat’s.

You may recall my passing interest in Aston Martin’s Cygnet, a leather-laden, almost pretty iQ that would have helped Aston raise its corporate fuel-econ average in Europe, as I suspect the Smart has done for Daimler in the States. But the Cygnet sold like turds at Tiffany, a blot on its ledger. Still, I hyped the Cygnet along with Cadillac’s hybrid \$76K ELR because they were luxurious, expensive, relatively rare compacts/subcompacts, a niche virtually nonexistent in my lifetime. Why couldn’t the ruddy-cheeked two-percenters be lured to cars smaller than a Chevy Suburban, even in times of cheap gas? Naïve is what I am, going on to propose to a few *C/D* staffers that we morph a luxu project car out of a Chevrolet Sonic. Next thing I know, I’m writing all my *C/D* stuff in Montana.

“Be careful what you wish for,” goes the tired rubric, but I never have, and Daimler and Aston and Cadillac are paying for it. I remember when Bob Lutz appeared at our Hogback Road HQ to show us a prototype Pontiac Solstice and GM’s internal photos of the still-somewhat-secret Saturn Sky. “Put a small V-8 in the Solstice so it’s Cobra-like instead of Miata-like,” I urged the silver-haired and -tongued Lutz. “And base the Sky on the mid-engined Toyota MR2.” Maximum Bob stared as if something had crawled out of my nose, and I ran my hand across my nostrils to make sure it hadn’t. Solstice and Sky? Dead and deader. And on the topic of fetid advice, I wonder how many auto journalists have urged manufacturers to proffer a mid-engined something or other. Thousands? Funny that the Smart was certainly mid-engined, its three-banger in front and on top of the rear axle, yet it, too, has plunged its head into the stink pool. I fear my beloved mid-engined Alfa 4C will follow, like those poor diving horses at early-1900s Coney Island. ■

John Phillips

DO YOU STEER CLEAR OF BAD CAR ADVICE?

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“As one judge said to another: ‘Be just and if you can’t be just, be arbitrary.’” That’s the late junk maven William S. Burroughs from *Naked Lunch*, a book every disaffected teenager started reading 20 times but failed to finish even once.

What I remember most from my aborted attempts: multiple uses of the word “spectral” and the original definition of “Steely Dan.” Anyway, it’s a great line. I don’t recall the context. Surely he was referring to the heat closing in on him or the tyranny of something or other. He was almost certainly not speaking about light trucks.

Yet, the sentiment nicely encapsulates the thinking at play when defining what is and what is not an SUV or other light truck. You might say, as I often do, who cares? There no longer exists a clear line between cars and trucks.

Instead, personal-use vehicles slot somewhere on a spectrum book-ended by the Smart Fortwo Electric Drive and the Ford F-series Super Duty, its center obscured by a cloud of small and mid-size crossovers. But, again, who cares? Would people think differently of a Volkswagen Tiguan if it were described as a wagon instead of as an SUV? That’s a rhetorical question.

At *C/D*, we sidestep the cars-versus-SUVs issue. In our spec charts, we refer to any vehicle that has four doors and a hatchback as a four-door hatchback.

But regulators can’t so easily let themselves off the hook. They can’t have manufacturers just making stuff up willy-nilly. There has to be a regulatory framework that keeps Smart from slapping an “Alpha Dog SUV, Unusually Large Horn Edition”

badge on its Fortwo and benefiting from less restrictive fuel-economy standards afforded to vehicles capable of doing more than just embarrassing their passengers. The truck standards were created for vehicles capable of towing boats and getting stuck deep in the woods.

And so it falls to entities such as the Environmental Protection Agency and the National Highway Traffic Safety Administration to create rules—many, many rules—governing the differences between cars and trucks that will seem ridiculous and unfair to the least number of interested parties. Get it wrong, and the PT Cruiser is classified as a truck, which it was per NHTSA, though it clearly wasn’t, per reality.

Enter Title 49, Part 523, Sections 4 and 5 of the Code of Federal Regulations. The complexity of that little ditty forced us to run the following passage in our September first-drive story on the 2018 VW Tiguan:

“Front-drive Tiguans come with seven seats, but you can get a Tiguan with only two rows if you opt for 4Motion all-wheel drive. Blame the feds for that weird anomaly: Front-drive models need the third row in order to be classified as a light truck; all-wheel-drive versions don’t.”

What? Clearly our writer was wrong, right? Wrong, our writer was right.

Section 523.4 defines what a “passenger

automobile” is. It’s pretty straightforward. A car is a vehicle that isn’t what’s described in Section 523.5. Oh, and the definition mentions parenthetically that a passenger vehicle not be one that is “capable of off-highway operation.” My personal experience, though, indicates that any car is capable of “off-highway operation.” It’s just a matter of for how long it is capable of it.

Section 523.5 is where things get weirdly specific. To be considered a “non-passenger automobile” (i.e., light truck), a vehicle must satisfy either Paragraph (a) or (b) of what follows. Paragraph (a) concerns cargo capabilities. If a vehicle can carry more than 10 persons; can serve as temporary housing; can carry cargo on an open bed; devotes more space to cargo than to passengers; or has at least three rows of seats, one or more of which can be folded or removed “with simple tools” to create a flat load floor—bingo!—you’ve got a truck.

Paragraph (b) concerns “off-highway” vehicles, which are also deemed light trucks by virtue of their perceived badassery. To satisfy the first part of the off-road provision, a vehicle must have “4-wheel drive or [be] rated at more than 6000 pounds gross vehicle weight.” To qualify for off-roadiness, a vehicle must also satisfy at least four of the following: approach angle of not less than 28 degrees, breakover angle of not less than 14 degrees, departure angle of not less than 20 degrees, running clearance of not less than 20 centimeters (7.9 inches), front and rear axle clearances of not less than 18 centimeters (7.1 inches) each. Why 7.1 inches? Or 7.9? Or 28 degrees? And how is there no description of what varieties of four-wheel drive count as “4-wheel drive”?

But who are we to complain about arbitrary parameters? Years ago, then editor-in-chief Csaba Csere, who shares nothing in common with Burroughs except a body mass index score, decreed that to be considered an SUV, a vehicle must (in addition to a few other attributes) be as tall as or taller than a Subaru Forester. So what we had was an easily applied, airtight rule but one that teetered on a single arbitrary decision.

This is just from one judge to another. ■



Daniel Pund

TOUGH IN THE RIGHT PLACES



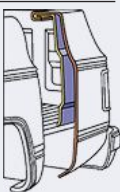
1977 Chevy Fleetside

Chevy Fleetside. Works hard, rides easy.

Everyone expects a pickup to be tough. And Chevy Fleetside delivers with Massive Girder Beam front suspension, double-wall body construction, computer-matched brake systems and a whole lot more. But with today's pickups doubling as family cars and RV's, Chevy Fleetsides are designed to be smooth riding, easy to move around and comfortable, too. And just as Chevy pickups offer a wide choice of engines and load capacities, the Fleetside gives you a big selection of colors, trims and available options.

Double-wall construction.

Chevy uses two walls of steel in the roof with a liner between the walls to help insulate the cab interior. Double-wall construction in the doors, upper cab panel, windshield



pillars and front cowl provide additional rigidity. You also get double-wall build in the hood, front fenders and Fleetside body side panels and tailgate.

Quick-release tailgate.

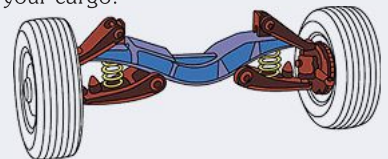
One person is all it takes. Simply release both retaining straps, then lift up on the right side to a 45° angle and pull out at the left. No tools needed. And it goes back on just as easy.



Toughness comes standard on Chevy Pickups and Vans.

Massive Girder Beam front suspension.

On 2-wheel drive models, a rugged steel beam with a tough coil spring at each end helps soak up most of the road shock before it gets to you and your cargo.



I'm not one to give advice, but here's some that I came by the hard way: Don't try to race a NASCAR driver on his own private dirt track. Especially don't do that in a turbo-charged Polaris RZR, which is explosively powerful but has the

center of gravity of James Comey wearing a lead top hat. Because what might happen is, you charge into Turn 2 a little hot, you fail to apply enough throttle to break the rear end loose, and those knobby tires dig into the clay and send you into a half-ass Joie Chitwood Thrill Show before you tumble 90 degrees off-kilter and hang there in your harness like a skydiver dangling in ornamental shrubbery. There's a moment when everyone checks that you're okay, and then the laughter commences. It's loudest from Joey Logano, owner of this particular North Carolina off-road playground. "I'm sorry," he says. "I've just wrecked so many times that it's hilarious when someone else does it."

If you're not familiar with Logano, I'll give you a few highlights. In 2014 at Richmond, he did a victory burnout down to bare rims. To announce the gender of his first baby, he did a burnout with tires that belled blue smoke. And once, he took his wife's grandmother for a ride in a car called the Panther and... didn't do a burnout. But



he did drive it into a lake—without first telling her that the Panther is amphibious. He's also won a bunch of NASCAR races.

Why am I at Logano's garage-slash-amusement park? Officially, to try out the new RZR XP Turbo EPS Dynamix, which has electronically adjustable dampers. But really to screw around. The spread is 27 acres, and Logano invites his friends over to race on the trails. Sometimes in side-by-sides, sometimes quads. "You should buy an old Crown Vic to bomb around in out here," I say. "Or six Crown Vics!" he replies. "Then we could race them." I like how this guy thinks.

Whether I like how he drives is still an open question. I've ridden with a lot of race-car drivers—Petter Solberg, Michael Schumacher—and none of them scared me. Logano scares the crap out of me. RZR's have a grab bar for the passenger, and at first, I think I'll be cool and not hold on to it. That lasts for about 15 seconds, at which point we're heading for a banked corner at 60 mph and I'm pretty certain we're going to shoot off into the clear blue sky, so I grab the handle just so the paramedics will know where to find my arms. Then somehow Logano wrestles the machine onto the banking, gives it even more throttle, and heads back the other way before I have time to process what just happened. "You should enter the Mint 400," I tell him. "What's

that?" he replies. He's like a guy who can drain shots from half-court and dunk from the foul line but trying out for the NBA hasn't really crossed his mind.

I'm always thinking about consequences, and here the consequence of too much throttle could've been an exciting trip into a metal stanchion. Logano hasn't contemplated this idea, nor the general notion of runoff, possibly ever. "I don't think it matters to me," he says. "Wall, cliff—I'd just be thinking, 'Well, better not go off that cliff!'"

We head inside for lunch and to ogle Logano's cars. Other than the Panther, the aforementioned amphibian, I'm drawn to the diesel Chevelle. It's tubbed and stuffed with a 1200-hp Duramax. I ask what it does in the quarter-mile, and Logano says he doesn't know because he can't get it to hook up. This seems like a reasonable explanation. It also has nitrous, though, just in case it ever does hook up.

Over lunch, we talk NASCAR and the challenge of translating the drivers' skills to TV. I tell him how I had to go up on the roof at Charlotte to really see what was happening in the corners—namely, that the cars are visibly sideways at 160 mph. "Oh, we're even sideways on the straights!" he says. "The cars are set up to turn, so they're kind of crabbing down the straight." So drivers are countersteering at 210 mph in heavy traffic. If only TV could make that look as cool as a Ken Block drift.

I opine that NASCAR would do well to mandate some production relevance for the on-track product, some clear link between track and showroom. "Like, what am I going to be doing, running an EcoBoost out there?" he asks. Yes! And the Chevys will have LT1s! The Toyotas will run i-Force V-8s, and we'll somehow make them about equal. If someone gets two laps ahead, we'll make him pull into the pits and pick up Ballast Barry, a 200-pound replica of one of Junior Johnson's hogs. We'll make it fair. You know, not like Logano's dirt track. "You would've been fine if you just gave it more throttle," Logano says. "The solution is always more throttle." Not bad advice. ■



SEE? DYER REALLY DID HANG OUT WITH LOGANO AND DIDN'T JUST MAKE THIS COLUMN UP (IMAGE PHOTOSHOPPED).

Ezra Dyer

TOUGH IN THE RIGHT PLACES



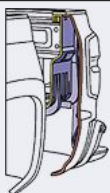
2018 Chevy Silverado

Chevy Silverado. Works hard, rides easy.

Everyone expects a pickup to be tough. And Chevy Silverado delivers with a rugged double-wishbone, coil-over-shock front suspension attached to a high-strength steel frame with through-welded cross members, Duralife™ brake rotors and a whole lot more. But with today's pickups doubling as crossovers and SUV's, Chevy Silverado is designed to be smooth riding, easy to move around and comfortable, too. And just as Chevy pickups offer a wide choice of engines and load capacities, the Silverado gives you a big selection of colors, trims and special editions, like the Centennial Edition featured here.

Double-wall construction.

Double-wall bed construction remains an industry standard today, but now Chevy also uses high-strength, roll-formed steel in the bed floor to make it less susceptible to puncture than aluminum.



And to help create a quiet cab, high-strength steel is used in much of the structure, including the pillars, roof rails and rocker panels.

EZ Lift & Lower tailgate.

The EZ Lift & Lower tailgate opens smoothly with no thud and can be closed with one hand, so you can load and unload cargo easily. For added convenience, there's also a CornerStep rear bumper and pocket hand grips built into the top of the side rails.



Strength comes standard on Chevy Pickups.

Rugged double-wishbone, coil-over-shock front suspension.

The fully independent system is precisely tuned for solid handling. The front shock module helps soak up most of the road shock before it gets to you and your cargo.



WHAT WAS TRUE THEN, IS TRUE NOW.

CELEBRATING 100 YEARS OF CHEVY TRUCKS

2018 Honda Accord Sport 2.0T ▾





CAN THIS CAR SAVE THE SEDAN?

Once the most popular vehicle segment in the land, the family sedan has been laid low by the crossover. The new, tenth-generation Accord hopes to strike a few punishing blows in return.

—by Tony Quiroga

—photography by Greg Pajo

H

ere we are, 17 years after the millennium, creeping toward a driverless future discussed elsewhere in this issue. Robocars will ask very little of us, only that we sit there and wait. After a few years of this, our driving skills are likely to atrophy like leg muscles in a cast. We'll all become as helpless as Miss Daisy, reliant on a robotic Hoke to drive us around.

Except maybe that's not what's going to happen because we just hopped into the cabin of a redesigned 2018 Accord and there's a manual gearbox with a leather-wrapped knob

between the seats. That shifter shouldn't be there, not this far into the driverless century. It's almost like finding out that Cadillac offered a hand-cranked starter in 1959. Of course that didn't happen, but if the robots win and the computer-driven car dominates mobility, this family sedan with a manual will certainly confuse the fossil record.

Naturally, we love it. Partially because a manual family sedan gives us hope that our enthusiasm might have a place in the future, but also because we've loved slamming Hondas into gear since the 1980s, and we'd like to continue doing so for at least a few more decades. Slick and precise, this six-speed—available only on Sport trims—provides a mechanical conduit between the car, the driver, and the 252-hp turbocharged 2.0-liter four-cylinder. We haven't tried the 10-speed automatic yet, an option we're guessing will cost about \$1000. The 2.0-liter is new and closely related to the 306-hp 2.0-liter in the Civic Type R. It replaces the previous generation's 278-hp 3.5-liter V-6 as the top-spec engine. Moving up to the 2.0-liter from the base 192-hp turbocharged 1.5-liter will require around \$1500 of your hard-earned grickles.

The Civic Type R bloodline is deeply felt in the Accord's new engine. Equipped with Honda's i-VTEC variable valve lift, the 2.0-liter delivers a rev happiness and linear thrust missing from the 1.5. It rewards you for running right up to the 6800-rpm redline. A hint of turbo lag is unmistakable, but it's a mere split second before the rush hits. In the Type R, the engine makes no attempt to fit in with polite society. Honda has

wisely buried the engine's more prurient tendencies for family-sedan use. At full throttle, the engine emits only 78 decibels, compared with the Type R's 91 decibels of Vin Diesel-inspired dialogue.

Pull through the first two gears, and the Accord hits 60 mph in 6.1 seconds; the quarter-mile rolls by in 14.7 seconds at 98 mph in fourth gear. The last V-6 Accord sedan, which came only with a six-speed automatic and weighed 310 pounds more than this wiry 3283-pound Accord, made it to 60 mph in 5.8 seconds and to the quarter-mile mark in 14.4 seconds at 99 mph. The turbo engine's rush of torque between 1500 and 4000 rpm gives the driver the impres-



2018 Honda Accord Sport 2.0T

[+] A manual Accord with power, practicality, and handling; never feels as if it's giving up.
 [-] Civic levels of road noise, it'd be nice to hear a bit more from the steering.
 [=] A subtle nod that says Honda stands with us for at least a few more years.



sion that the new car is quicker than its measurements, but all that output will light up the front tires in first gear. Even with the front end hunting for traction, the steering doesn't tug and the nose doesn't spastically vector you into ditches or oncoming traffic; you merely feel as if you're accelerating on a damp road before traction control steps in.

Cornering grip, at 0.87 g, is strong for a family sedan and is achieved on the Sport model's 235/40R-19 Goodyear Eagle Touring all-season tires. The Accord is easy to manage near the limit and remains composed, even if the steering efforts through the leather-wrapped rim are a bit light and the electronically assisted gag ensures that its voice is largely muted. Like its predecessor, this Accord is light on its feet and stays flat in corners, and that competence goads you to go ever faster.

Drive it as if you just signed up to be an Uber driver, and you'll find the ride to be firm enough to be interesting between fares but supple enough to earn you five stars from passengers. The structure is solid, but this latest generation does not seem to have turned down the volume on road and tire noise. The Accord's 70 decibels at 70 mph is only a single decibel up on the old V-6 model, but it's enough to keep this sedan from being confused with a luxury car.

Right: This 2.0-liter is close kin to the Civic Type R's. Below: The Honda ethos of "man maximum, machine minimum" is felt in the roomy back seat.





Rear-seat space is luxury-car massive, however. Legroom and shoulder room are abundant, even for six-foot-tall adults. The driver's seat padding is hard, but it starts to feel supportive after a couple of days. And in typical Honda fashion, there's space for all the accessories of 21st century life. Deep cubbyholes in the center console, under the armrest, and in the doors easily swallow all your phones, charging equipment, iPads, Kindle readers, and Oprah Cinnamon Chai Crème Frappuccinos.

There's more modern technology perched atop the dashboard, where Honda has wisely upgraded the Accord's infotainment system. Gone is the previous car's

slow-acting unit whose displays had all the charm of a computer running Windows 95. A new eight-inch screen (a seven-incher is standard on 1.5T and hybrid models) reliably responds to the briefest of taps, the layout is logical, and there are redundant buttons around the perimeter to make even your first attempt at using it easy. With it, Honda has gone from being one of the worst infotainment providers to a class leader. There's even a dedicated volume knob on the left and a tuning knob on the right, just as RCA and Philco intended.

The rest of the interior holds few surprises. Climate controls are simple, just three knobs with a few logically marked

2018 HONDA ACCORD SPORT 2.0T

PRICE
AS TESTED **\$30,000***
BASE \$30,000*

VEHICLE TYPE: front-engine, front-wheel-drive, 5-passenger, 4-door sedan

OPTIONS: none

AUDIO SYSTEM: satellite radio, Bluetooth-audio inputs, Android Auto and Apple CarPlay interfaces, 9 speakers

ENGINE

turbocharged and intercooled inline-4, aluminum block and head

BORE X STROKE 3.39 x 3.38 in, 86.0 x 85.9 mm

DISPLACEMENT 122 cu in, 1996 cc

COMPRESSION RATIO 9.8:1

FUEL DELIVERY SYSTEM: direct injection

TURBOCHARGER IHI RH5

MAXIMUM BOOST PRESSURE 21.0 psi

VALVE GEAR: double overhead cams, 4 valves per cylinder, variable intake- and exhaust-valve timing and lift

REDLINE/FUEL CUTOFF 6800/6900 rpm

POWER 252 hp @ 6500 rpm

TORQUE 273 lb-ft @ 1500 rpm

DRIVETRAIN

TRANSMISSION: 6-speed manual

FINAL-DRIVE RATIO 3.84:1

GEAR	RATIO	MPH PER 1000 RPM	MAX SPEED IN GEAR (rpm)
1	3.63	5.4	37 mph (6900)
2	2.12	9.1	63 mph (6900)
3	1.53	13.0	90 mph (6900)
4	1.13	17.7	122 mph (6900)
5	0.85	23.6	125 mph (5300)
6	0.69	29.1	125 mph (4300)

CHASSIS

unit construction with rubber-isolated rear subframe

BODY MATERIAL: steel and aluminum stampings

STEERING

rack-and-pinion with variable ratio and variable electric power assist

OVERALL RATIO 11.8:1

TURNS LOCK-TO-LOCK 2.2

TURNING CIRCLE CURB-TO-CURB 39.4 ft

SUSPENSION

F: ind, strut located by lower control arm, coil springs, anti-roll bar

R: ind; 1 trailing arm, 2 lateral links, and a toe-control link per side; coil springs; anti-roll bar

BRAKES

F: 12.3 x 1.0-in vented disc, 1-piston sliding caliper

R: 11.1 x 0.4-in disc, 1-piston sliding caliper

STABILITY CONTROL partially defeatable

WHEELS AND TIRES

WHEEL SIZE 8.5 x 19 in

WHEEL CONSTRUCTION cast aluminum

TIRES: Goodyear Eagle Touring, 235/40R-19 M+S

EXTERIOR DIMENSIONS

WHEELBASE	111.4 in
LENGTH	192.1 in
WIDTH	73.2 in
HEIGHT	57.1 in
FRONT TRACK	63.0 in
REAR TRACK	63.4 in
GROUND CLEARANCE	5.9 in

INTERIOR DIMENSIONS

PASSENGER VOLUME	F: 54 cu ft	R: 49 cu ft
TRUNK VOLUME	17 cu ft	

CAR AND DRIVER TEST RESULTS

ACCELERATION

ZERO TO	SECONDS
30 MPH	2.3
40 MPH	3.7
50 MPH	4.9
60 MPH	6.1
70 MPH	8.1
80 MPH	9.9
90 MPH	12.4
100 MPH	15.3
110 MPH	18.3
120 MPH	21.8
TOP GEAR, 30-50 MPH	10.8
TOP GEAR, 50-70 MPH	7.6
1/4-MILE	14.7 sec @ 98 mph
TOP SPEED	125 mph (gov ltd)

HANDLING

ROADHOLDING, 300-FT-DIA SKIDPAD	0.87 g†
UNDERSTEER	MINIMAL

*C/D estimated. †Stability-control inhibited.

Opposite page, right: The tach side of the gauges is reconfigurable; John Cuellar is sure to be upset about the directional wheels.

ual, we left the tachometer displayed. We do wish that Honda gave drivers the option of putting a digital speedometer in the vast darkness between the two gauges.

Maybe it's because we've been visually assaulted by other new Hondas, such as the Civic and fuel cell-powered Clarity, but we find the new Accord attractive. In front, a broad black grille is topped by a large chrome band that makes it look as if the Accord is wearing a wrestling-championship belt (an acknowledgment of all its past 10Best wins?). Honda's Intercontinental tag-team belt is

buttons. A convincing digital facsimile of an analog tachometer is set to the left of an actual analog speedometer. It's possible to change the tachometer display to show trip-computer, audio, and other information, but, this particular car being a manual, but, this particular car being a manual,

flanked by LED headlights that look as if they could've come from an Acura and shine brightly at night.

The Accord's outward appearance may conform to class norms, but Honda isn't a follower. Offering a manual transmission in the Accord is a protest of sorts, a secret handshake from Honda that lets us know that you shouldn't have to give up driving just because you're buying a family sedan. Life may get lost in a repetitive blur of cubicles, choosing paint colors at Home Depot, eating meatballs at Ikea, and picking up the kids from karate. But a manual Accord—a really fun and powerful Accord at that—serves as a reminder of the joy and freedom we used to have as drivers back in the 20th century. Call it an anachronism or an anomaly, but the stick shift belongs to us, those who love driving. We will not give up and let our left legs and right arms wither away. The manual transmission's therapy is as much mental as it is physical. ■



BRACING, 70-TO-ZERO MPH

SHORTEST STOP	164 ft
LONGEST STOP	170 ft
FADE RATING	NONE

WEIGHT

CURB	3276 lb
PER HORSEPOWER	13.0 lb
DISTRIBUTION	F: 60.3% R: 39.7%
CENTER-OF-GRAVITY HEIGHT	21.5 in
TOWING CAPACITY	1000 lb

FUEL

CAPACITY	14.8 gal
OCTANE	87
EPA COMBINED/CITY/HWY	28/25/34 mpg
C/D OBSERVED	28 mpg

INTERIOR SOUND LEVEL

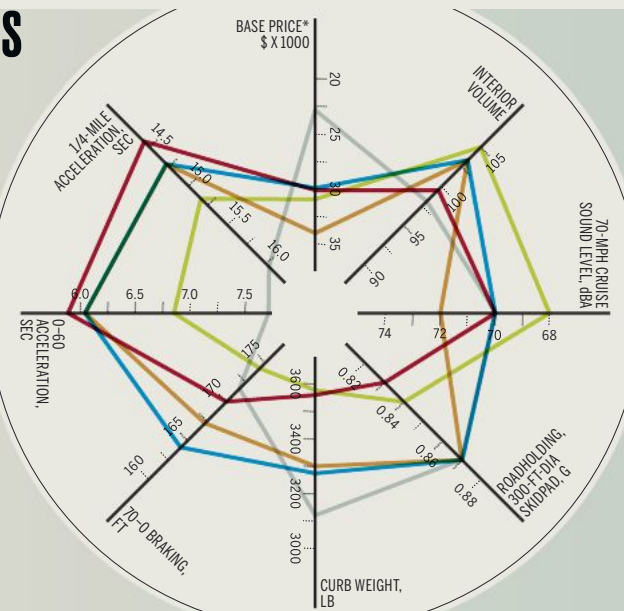
IDLE	41 dBA
FULL THROTTLE	78 dBA
70-MPH CRUISING	70 dBA

COMPETITORS

The Honda Accord Sport and the Chevrolet Malibu put up virtually identical performance numbers. But the Accord feels much lighter on its toes.

HONDA ACCORD SPORT 2.0T
2.0-L I-4, 6-SP MAN
CHEVROLET MALIBU 2.0T PREMIER
2.0-L I-4, 8-SP AUTO
MAZDA 6 SPORT
2.5-L I-4, 6-SP MAN
KIA OPTIMA SX 2.0T
2.0-L I-4, 6-SP AUTO
VOLKSWAGEN PASSAT SE
3.6-L V-6, 6-SP AUTO

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Premium Gasoline
The Official Fuel of
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NAMING

In a shrouded corner of the utility-vehicle cosmos sit these hard-to-label pragmatists that aim to balance extravagance and enjoyment.



▲
**MERCEDES-AMG
GLC43**
Price: \$71,055
Power: 362 hp
Torque: 384 lb-ft
Weight: 4237 lb
C/D observed: 18 mpg



▲
AUDI SQ5
Price: \$65,800
Power: 354 hp
Torque: 369 lb-ft
Weight: 4429 lb
C/D observed: 19 mpg

RITES

_by Josh Jacquot
_photography by Greg Pajo



▲
PORSCHE MACAN S

Price: \$64,905
Power: 340 hp
Torque: 339 lb-ft
Weight: 4347 lb
C/D observed: 17 mpg





C

ar enthusiasts and physics concur: Tallness is inherently at odds with fun. At least when it comes to driving; Wilt Chamberlain probably disagreed. Regardless, the tall, banal crossover proliferates. So abundant are these be-hatched trucklets that we find ourselves desperately trying to classify them, adding words such as “premium,” “compact,” and—wait for it—“performance.” Yet those three adjectives aptly characterize the machines before you, all of which occupy a tiny but expanding corner of the crossover universe.

Despite the funneling of crossovers into ever-smaller buckets, narrowing the field for this test was actual work. Alphabetically, then: Alfa’s Stelvio effectively straddled our field’s \$55,000 base-price/350-hp requirement with a 280-hp, \$42,990 starting model and a 505-hp, \$77,000 Quadrifoglio. BMW’s X3 and X4 M40i had similar problems, the X3 lacking power and the appropriately priced and competitively powerful X4 M40i lacking a practical roofline.

Infiniti’s QX70 is just too old, its last redesign coming almost a decade ago. Jag’s F-Pace was beaten in our visit to this segment in 2016, and Volvo’s hottest XC60 powers its rear axle with an electric motor.

That leaves Audi’s freshly minted SQ5, Mercedes-AMG’s GLC43, and our returning champ, Porsche’s Macan. To save \$12,800 this go-round, though,

we’ve substituted the Macan S for the GTS, which showed its rounded rump to the Jag in last year’s matchup. There is an immense amount of common ground among the three assembled, starting with base prices, all of which fall within an improbable \$620 window. All three are powered by longitudinally arranged turbocharged 3.0-liter V-6 engines and come standard with all-wheel drive. All are within a single inch of one another in overall length.



And all three were created to reconcile the absurdly American priorities of sitting high and going fast.

Built on the VW Group's MLB Evo platform, which also carries the S4 and S5, the 354-hp SQ5 starts at \$55,275 (in Premium Plus trim) and is the newest crossover in this contest. Its Prestige package, which includes navigation, Audi's Virtual Cockpit configurable instrument cluster, and a few more tricks, added \$4200 to our tester. Another \$3000 tapped the S Sport package, endowing the SQ5 with red brake calipers, a torque-vectoring rear differential, and height-adjustable air suspension, for when you can't resist the suburban Rubicon. Rounding out the performance options are \$1000 21-inch wheels. All in, this is a \$65,800 SQ5.

With 362 horsepower and a \$71,055 as-tested price, the GLC43 is both the most powerful and most expensive vehicle in this test. Don't blame its \$55,895 base price, though—there's plenty of fat to cut from our heavily equipped example. Capable self-parkers, we'd gladly surrender the \$1550 Advanced Parking Assistance package. Forgoing another \$4130 in paint and upholstery options would put

It's a regal perch, this SQ5, all chromed and quilted as it is. Those red calipers cost \$3000 but also net an air suspension and a sport rear differential.

the GLC's as-tested price right between those of the Macan and SQ5. Being an AMG means most of the performance options, such as height-adjustable air springs, are built into the base price, but 21-inch wheels come with a \$1000 burden here. Navigation and multiple driver-assist and safety features are provided by the \$5950 Premium package.

As our reigning champ of all things small, tall, and sporting, Porsche's Macan uses VW's older MLB platform shared with the previous Audi A4, S4, and Q5 variants. With 340 horsepower and at \$64,905 as tested, it proffers the most modest output and price in the test. Four performance-enhancing options totaling \$5400 stand out: Porsche Active Suspension Management, Porsche (brake-based) Torque Vectoring Plus, 20-inch wheels, and the Sport Chrono package. Our tester also came equipped with navigation, lane-change assist, and heated front seats.

Though we might not know exactly what to call these things,



*Stability control inhibited.



Audi SQ5
[+] Audi elegance and tech,
relaxed comfort. [-] Not as big as
you're led to believe; newest, but
already off the pace. [=] A very
likable character that finds itself
in the unfortunate position of
finishing last.

we do know just where to drive them. Continuing a long tradition of incensing the Ohio State Highway Patrol, we headed out from Ann Arbor, Michigan, to southern Ohio's Hocking Hills where the roads are technical, fraught with blind crests, and tighten mid-corner. We logged 700 miles in three days, smoking brakes, scrubbing tires, and having, well, fun to reach this conclusion.

3. AUDI SQ5

But wait, you say, this is the newest and best from the company that arguably first laid claim to the tiny piece of performance pie in dispute here. And truth be told, this SQ5 is a very solid machine. Well, solid is the wrong word since the SQ5 is the softest of the threesome, even in Dynamic mode. It rolls where the GLC and Macan stand straight. Despite tying the GLC for the most lateral grip (0.93 g), it washes out sooner when pushed in corners and it speaks with a heavy accent that sounds a lot like understeer much of the time. Its on-road behavior is at odds with the easy rotation induced by its torque-vectoring rear differential in slalom testing (where,

	2018 AUDI SQ5	2017 MERCEDES- AMG GLC43	2017 PORSCHE MACAN S
PRICE AS TESTED	\$65,800	\$71,055	\$64,905
BASE PRICE	\$55,275	\$55,895	\$55,450
DIMENSIONS			
LENGTH	183.9 in	183.5 in	184.3 in
WIDTH	74.5 in	76.0 in	76.1 in
HEIGHT	65.3 in	64.1 in	63.9 in
WHEELBASE	111.2 in	113.1 in	110.5 in
FRONT TRACK	63.9 in	64.5 in	65.2 in
REAR TRACK	63.6 in	65.2 in	65.0 in
INTERIOR VOLUME	F: 55 cu ft R: 47 cu ft	F: 51 cu ft R: 47 cu ft	F: 52 cu ft R: 44 cu ft
CARGO BEHIND	F: 60 cu ft R: 27 cu ft	F: 57 cu ft R: 19 cu ft	F: 53 cu ft R: 18 cu ft
TOWING			
MAX	4400 lb	3500 lb	4409 lb
POWERTRAIN			
ENGINE	turbocharged DOHC 24-valve Miller-capable V-6 183 cu in (2995 cc)	twin-turbocharged DOHC 24-valve V-6 183 cu in (2996 cc)	twin-turbocharged DOHC 24-valve V-6 183 cu in (2997 cc)
POWER HP @ RPM	354 @ 6400	362 @ 6000	340 @ 6500
TORQUE LB-FT @ RPM	369 @ 1370	384 @ 2500	339 @ 1450
REDLINE/FUEL CUTOFF	6500/6500 rpm	6500/6500 rpm	6800/6800 rpm
LB PER HP	12.5	11.7	12.8
DRIVELINE			
TRANSMISSION	8-speed automatic	9-speed automatic	7-speed dual-clutch automatic
DRIVEN WHEELS	all	all	all
GEAR RATIO:1/	4.71/5.6/36	5.35/4.2/27	3.69/5.2/35
MPH PER 1000 RPM/	3.14/8.3/54	3.24/7.0/46	2.15/8.9/61
MAX MPH	2.11/12.4/81	2.25/10.0/65	1.41/13.6/92
	1.67/15.7/102	1.64/13.8/90	1.03/18.6/126
	1.29/20.3/127	1.21/18.7/122	0.79/24.3/156
	1.00/26.2/127	1.00/22.6/132	0.63/30.5/156
	0.84/31.1/127	0.86/26.3/132	0.52/36.9/156
	0.67/39.0/127	0.72/31.4/132	
		0.60/37.6/132	
FINAL-DRIVE RATIO:1	3.20	3.69	4.40
CHASSIS			
SUSPENSION	F: multilink, air springs, anti-roll bar R: multilink, air springs, anti-roll bar F: 13.8-inch vented disc R: 13.0-inch vented disc	F: multilink, air springs, anti-roll bar R: multilink, air springs, anti-roll bar F: 14.2-inch vented, cross-drilled disc R: 12.6-inch vented disc partially defeatable, competition mode	F: multilink, coil springs, anti-roll bar R: multilink, coil springs, anti-roll bar F: 13.8-inch vented disc R: 13.0-inch vented disc
BRAKES			
STABILITY CONTROL	partially defeatable, competition mode, launch control	partially defeatable, competition mode	partially defeatable, launch control
TIRES	Pirelli P Zero P24 255/40R-21102Y	Continental ContiSportContact 5P F: 255/40ZR-21102Y R: 285/35ZR-21105Y	Michelin Latitude Sport 3 F: 265/45R-20104Y R: 295/40R-20106Y

CAR AND DRIVER TEST RESULTS

ACCELERATION			
0-30 MPH	1.7 sec	1.6 sec	1.6 sec
0-60 MPH	5.1 sec	4.3 sec	4.7 sec
0-100 MPH	13.0 sec	11.6 sec	12.4 sec
0-120 MPH	20.2 sec	17.8 sec	19.1 sec
1/4-MILE @ MPH	13.7 sec @ 102	13.1 sec @ 105	13.3 sec @ 103
ROLLING START,			
5-60 MPH	6.1 sec	5.5 sec	6.4 sec
TOP GEAR, 30-50 MPH	3.4 sec	3.3 sec	3.3 sec
TOP GEAR, 50-70 MPH	4.0 sec	3.9 sec	4.1 sec
TOP SPEED	127 mph (gov ltd)	132 mph (gov ltd)	156 mph (drag ltd, mfr's claim)
CHASSIS			
BRAKING, 70-0 MPH	148 ft	154 ft	155 ft
ROADHOLDING,			
300-FT-DIA SKIDPAD	0.93 g	0.93 g	0.91 g
610-FT SLALOM	43.9 mph*	45.4 mph*	44.8 mph*
WEIGHT			
CURB	4429 lb	4237 lb	4347 lb
%FRONT/%REAR	54.3/45.7	55.0/45.0	56.9/43.1
CG HEIGHT	24.0 inches	25.5 inches	24.5 inches
FUEL			
TANK	18.5 gal	17.4 gal	19.8 gal
RATING	91 octane	91 octane	91 octane
EPA COMBINED/CITY/HWY	21/19/24 mpg	20/18/24 mpg	19/17/23 mpg
C/D 700-MILE TRIP	19 mpg	18 mpg	17 mpg
PRACTICAL STOWAGE			
NO. OF 9 X 14 X 22-IN BOXES,			
SEATS UP/FOLDED	6/20	7/19	6/16
LENGTH OF PIPE	125.5 in	124.0 in	122.0 in
LARGEST FLAT PANEL,			
LENGTH X WIDTH	68.0 x 40.3 in	66.8 x 42.8 in	66.0 x 40.5 in
SOUND LEVEL			
IDLE	37 dBA	40 dBA	43 dBA
FULL THROTTLE	76 dBA	80 dBA	75 dBA
70-MPH CRUISE	66 dBA	69 dBA	67 dBA

*Stability-control inhibited.



Porsche Macan S

[+] The eternal driver's tool, even in crossover disguise; real launch control. **[-]** In an ever-enlarging world, being the oldest hurts; features out of proportion with cost. **[=]** The one you want if driving matters most; of course, there's also a Cayman for that.

belies the reality of its roominess. It leads the pack in hard metrics such as interior volume and cargo space, yet when we packed its back seat with our 6-foot 2-inch deputy editor, he complained loudly about the territorial dispute happening between his head and the roof. With three across in the rear seat, the SQ5 felt no roomier than the dimensionally smaller Macan.

Driver comfort is a win in the Audi, which offers enough space for even the oafiest among us while still coddling the bony backsides of the avians on staff. And its interior is our most preferred combination of striking modern tech and intuitive usability. But despite a tie for the win in roadholding and making the shortest 70-to-zero-mpg full stop, the SQ5 ranks lowest in our fun-to-drive category. Coupled with the damage done by its deceptive back-seat space and worst-in-test acceleration, the SQ5 finds itself, precariously, a righteous crossover in last place.

2. PORSCHE MACAN S

It's telling that the Macan makes the least grip in the group (0.91 g) but decisively excels at every subjective measure of chassis evaluation. Its steering and brake feel, ride quality—with the only steel springs in the

incidentally, it was still the slowest). Being the tallest and heaviest member of the trio likely has something to do with all this.

The SQ5's V-mounted twin-scroll turbocharger, however, is a lag-free ally delivering boost response that resolutely follows its driver's right foot. Paired with ZF's eight-speed auto, thrust is only a pedal stroke away. Even so, this transmission, which we've praised in so many applications, swapped cogs noticeably slower than the Mercedes and the Porsche gearboxes and delivered the occasional slurred shift at part throttle. The SQ5 is the slowest to 60 and through the quarter-mile, completing those milestones in 5.1 and 13.7 seconds, respectively.

But crossovers—even these crossovers—shouldn't live and die on performance alone, so the SQ5 does its dying inside, too, where the promise of its big numbers





test—and handling scores are all tops here. That, friends, is the Porsche magic. It's not about numbers, it's about feel. That same deputy editor who so disliked the SQ5's back seat succinctly summed up the Macan:

"The others feel as if they've had performance added to them, while it's just built into the Macan." And so it goes. Flowing confidently over square-edged swells, dancing effortlessly through overcooked closing-radius turns, and laughing off the occasional airborne crest, the Macan is the

The Macan S is the driver's compact performance crossover of the group, with lots of 911 in its bones (and its cockpit layout).

machine to buy if you're a driver in need of a crossover. Its seven-speed dual-clutch transmission is ultraquick and obedient and offers the most intuitive shifter in the group. The Macan might not win this test overall, but it

certainly wins our hearts.

Also, it's not slow. As the only vehicle here with a legitimate launch control, it rules the Stoplight Summernationals by revving to an honest 5000 rpm before pinning its passengers to the seatbacks. Sixty arrives in 4.7 seconds, the quarter-mile in





The GLC43 charmed us with its fastest-in-test acceleration and high feature content. That it has the comfiest rear seat didn't hurt, either.

13.3, and it continues, according to Porsche, all the way up to 156 mph.

But the Macan's powertrain lacks both the flexibility and the responsiveness of the others. Sure, the PDK is immediate, but the engine's lower torque coupled with taller overall gearing and fewer gears diminishes the Macan's urgency in many situations where urgency is an asset. Also, it didn't go unnoticed that the lowest-output vehicle in the test also came with the worst observed fuel economy, at 17 mpg.

Inside, it's the smallest. Especially up front, where a sense of airiness and space is as important as actual volume. The Porsche's flowing body lines and curved fenders—we like them the most, incidentally—deny it roominess. The Audi might struggle in practice, but the Macan actually measures smallest, both in interior volume and in our practical tests where we put real boxes in real cargo areas. And when it comes to features, you get less for your money in the Macan than in either the Audi or Mercedes. The Macan's base seats aren't all leather and they lack the adjustability of their competitors'. So the driver's cross-over makes compromises that prevent it from winning a contest that rewards comprehensive achievement. That means it's not the best vehicle overall, but it still might be the best one for you.

1. MERCEDES-AMG GLC43

Here's something we didn't expect to say: The GLC is the lightest and quickest-accelerating crossover in this test. It tore its way to 60 in 4.3 seconds, a full 0.4 second



FINAL RESULTS

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CAR AND DRIVER

▲ **MERCEDES-AMG GLC43**
Maximum points available

PORSCHE MACAN S

AUDI SQ5

RANK	1	2	3
VEHICLE			
DRIVER COMFORT 10	8	7	9
ERGONOMICS 10	7	6	7
REAR-SEAT COMFORT 5	4	3	2
REAR-SEAT SPACE* 5	5	4	5
CARGO SPACE* 5	4	2	5
FEATURES/AMENITIES* 10	10	5	8
FIT AND FINISH 10	9	8	8
INTERIOR STYLING 10	8	7	8
EXTERIOR STYLING 10	8	9	7
REBATES/EXTRAS* 5	0	0	0
AS-TESTED PRICE* 20	18	20	20
SUBTOTAL 100	81	71	79
POWERTRAIN			
1/4-MILE			
ACCELERATION* 20	20	19	17
FLEXIBILITY* 5	5	3	5
FUEL ECONOMY* 10	9	8	10
ENGINE NVH 10	9	8	7
TRANSMISSION 10	9	9	7
SUBTOTAL 55	52	47	46
CHASSIS			
PERFORMANCE* 20	20	19	20
STEERING FEEL 10	8	9	7
BRAKE FEEL 10	8	9	6
HANDLING 10	8	9	7
RIDE 10	8	8	8
SUBTOTAL 60	52	54	48
EXPERIENCE			
FUN TO DRIVE 25	19	22	15
TOTAL 240	204	194	188

*These objective scores are calculated from the vehicle's dimensions, capacities, rebates and extras, and/or test results.

quicker than the Macan. And its powertrain shows huge flexibility by trouncing the others in our 5-to-60-mph test, beating the Audi by 0.6 second and the Porsche by 0.9. In Sport Plus, it is full of snort, ripping off full-throttle upshifts with a barely subdued blat. Gear-changes come with a kidney-punching whack and feel every bit as quick as those from Porsche's PDK dual-clutch transmission.

Though it's not our go-to vehicle when the speed climbs and the road turns, the GLC reveals shocking capability on our test loop. Its steering ratio isn't quite as quick as the Macan's, but its response is more immediate thanks to zero-lean roll stiffness. But enough is enough. The head-snapping lateral motions it produces aren't in any way justified by the grip it generates, even if it ties for the lead at 0.93 g. We found ourselves softening the damping to dial in compliance while retaining aggressive throttle and transmission settings to achieve a balance that is, if not as comfortable as the Macan's, easily as rapid.

While the Audi's rear-seat volume matches that of the Mercedes, the GLC's back bench delivers both two- and three-passenger comfort, providing the headroom and the width necessary to accommodate adults. And to balance its cost, the GLC delivers features not found on either of the others, such as adaptive cruise control. It is as artfully finished as the Audi, and its buttons and knobs are refreshingly usable. Though we might not have a great label for the segment in which it competes, we do have one for the GLC: winner. 🏆

Mercedes-AMG GLC43
[+] Takes-no-lip quick, a striking driver, best rear seat in the bunch, lightest.
[-] Lateral immediacy makes us want a frontal lobotomy.
[=] The best combination of quick and usable.







11.2017 _ Car and Driver _ p.059

_ fitter, happier, more productive.

_ auto no mo', us

_ The fully computer-driven car is supposedly imminent. Is driving dead? We take a close look.

_ edited by
Malcolm Gladwell

illustrations by Tavis Coburn _



_ concerned but powerless.

What happens when we give up control?

_ A history of unintended consequences. _ by Malcolm Gladwell

The first automobiles, in the early 1900s, were a headache. The tool kit of the 1907 Pierce Arrow included, ominously, an extra set of intake and exhaust valves. Cars needed weekly oil changes. One manual of the period suggested that drivers have on hand, among other things, a small pipe wrench, a pair of gas pipe pliers, large and small screwdrivers, a pair of flat-nosed pliers, a small hammer, a pair of wire cutters, a large jackknife, half-round and three-cornered files, a roll of sticky tape, a chisel, a coil of soft iron, a monkey wrench, a few links of extra chain, a piece of asbestos for making gaskets, cans of oil and grease, and extra plugs. In response, owners adapted the model they had been using for years with their horses and carriages. The coachman—the man responsible for managing the army of stablehands and grooms who kept horses fed and shod and carriages clean and functional—was transformed into the chauffeur. Responsibility for the new technology was outsourced.

“Most wealthy motorists simply wanted to enjoy the exhilaration of speed and the freedom of long-distance travel without rails, which automobiles offered,” historian Kevin Borg writes in his wonderful essay, “The ‘Chauffeur Problem’ in the Early Auto Era.” “More than that, [owners] wanted to share these experiences with their social peers. These motorists viewed the automobile trip as a social setting within which the mechanical demands became a distraction, a nuisance, and possibly even an embarrassment.” The car was to its first owners an instrument of convenience.

What happened next, Borg writes, was a disaster. The guardians of the new technology misbehaved. They took kickbacks from garages. They were rude. They hired out their owners’ cars after hours (a move known as “hacking it”). “Between 1903 and 1912, howls of protest arose over chauffeurs’ arrogance and insubordination,” Borg writes, “and the pages of the automotive trade press overflowed with letters, articles, and editorials describing, complaining about, and offering solutions to the ‘chauffeur problem.’” Alarmed owners were forced to crack down. Drivers’ licenses originated as a means of reining in the early chauffeurs. Garages installed security systems. Meanwhile, cars themselves grew steadily more reliable, making the chauffeur less and less necessary. And as the automobile matured, owners ultimately realized that what they wanted from the new technology was not convenience at all. They wanted control. They discovered that the act of driving was the kind of pleasure best kept for themselves.

The chauffeur problem reminds us that in any period of technological transition, what proves vexing is not the technology itself. It’s working out the details, rules, and social expectations around the technology. In the same period, the fledgling telephone industry was promoting its groundbreaking technology as a business



instrument and actively discouraging potential customers from using the device for socializing and gossiping. They had the talking-by-

wire part figured out. But it took until the 1920s for them to figure out what talking by wire was for. The cellphone, similarly, was a phone first, then a portable telex, and now increasingly a gadget for posting photographs to Instagram and Snapchat. There is a lot of confusion in the earliest stage of any technological disruption, which brings us to the reason for this special section of *Car and Driver*. The autonomous-vehicle revolution is beginning, and we are now very much in the confusing stage.

Speaking of confusion, can we start with the phrase “autonomous vehicle”? Who came up with this term? A human piloting a car is autonomous. The driver slows and speeds up or turns and stops entirely as he or she chooses. Autonomy was the point of getting rid of the chauffeurs. The new class of electronically directed vehicles is the opposite of autonomous: It is a return to the idea that we are better off leaving the task of driving to a third party. The phrase “self-driving car” is worse. The self-driving car does the opposite of drive itself. It is a vehicle embedded in a technological grid, tethered to the driving environment by a system of sensors and algorithms. Words like “autonomous” and “self-driving” mislead because they promise a kind of self-sufficiency on the part of the machine. The autonomous entity is the thing that is supposed to take care of itself. But the coming class of cars does not take care of itself at all. These cars are dependent and, as such, require a larger conversation about what the rules and expectations of that dependency should look like. Once a car belongs to a network, you

have to worry about whether the network is safe. Once an algorithm is in command, you have to worry about how the algorithm thinks. We are surrendering control as surely as the first car owners of a century ago did, and when you surrender control, you could end up with a chauffeur problem.

One of the most read essays of the moment appeared not long ago in the *Atlantic* magazine. Written by Jean M. Twenge, "Have Smartphones Destroyed a Generation?" tells a troubling story: Today's teenagers go out less and are less likely to hold a job. Depression and suicides have soared. A kind of passivity has set in, and Twenge argues, persuasively, that the smartphone is the main culprit. This is not, of course, what the creators of the smartphone anticipated. The remarkable device that is the contemporary phone is the result of thousands of brilliant programmers and engineers working in parallel to push the boundaries of portable electronics further than ever before. They focused on what their invention would do. They rarely thought about the broader implications of their efforts—except to blithely assure us that the computer in our pocket would liberate and energize. The creators of new technologies pursue their own agenda. But it is not always the agenda of users.

We are now in the same situation with the automobile. It wasn't Audi, Ford, or GM that pushed hardest for the dependent vehicle. It was Apple, Google, and Intel, companies for which the automobile is not primarily an aesthetic object and driving is not an instrument of pleasure. And the users they have in mind, needless to say, are not the readers of *Car and Driver*. They are the kids lying passively on the couch with their smartphones. "Nearly all boomer high-school students had their driver's license by the spring of their senior year; more than one in four teens today still lack one at the end of high school," Twenge writes. "In conversation after conversation, teens described getting their license as something to be nagged into by their parents—a notion that would have been unthinkable to previous generations." *These motorists viewed the automobile trip as a social setting within which mechanical demands became a distraction, a nuisance, and possibly even an embarrassment.*

Heaven help us. ✕

will frequently check credit at moral bank.

How safe

When it comes to computer-driven cars, reducing traffic fatalities will be far easier than earning drivers' trust.

by Tom Vanderbilt

O

ne morning this past spring, Baruch Fischhoff, a professor in the department of engineering and public policy at Carnegie Mellon University, was walking to campus on a quiet tree-lined Pittsburgh street when a prototype computer-driven Uber, a gray Volvo XC90, motored slowly past.

Pittsburghers have grown accustomed to seeing the vehicles prowling the streets of the company's de facto outdoor test bed. But as Fischhoff approached the corner,

he noticed a road crew and a cement mixer in the middle of the intersection. "I thought, 'Gee, I wonder if the computer can figure out if this is something in the road that's not moving.'"

He waited for the car, which was idling to his left, to make a right turn—the only plausible move. But it did nothing. "It was there first, it had the right-of-way, and I was waiting for it to turn," he said. Still, the car did nothing. "The longer I waited, the less willing I was to trust that the computer would make the right decision." Finally, the human stationed inside the car tapped on the window and silently motioned him across.

Fischhoff, who studied math and psychology—and who trained with both Daniel Kahneman and the late Amos Tversky, giants in the field of the psychology of decision making—is one of the world's leading scholars on the psychology of risk. There is a cosmic irony in the idea of Fischhoff standing on a corner, trying to calculate what this machine was going to do, what he should do, and how he felt about the whole thing.

We are all, in a sense, standing on the corner, caught between the whirlwind of breathless news about the driverless future and our own uncertain sense of what that looks like and, more important, what our comfort level with that future is.

In terms of saving lives, driverless vehicles, on paper anyway, make sense: Simply remove the possibility of fatigue or alcohol impairment in a driver, and you have just knocked 45.5 percent off

is safe enough?

the fatality rate in the U.S.—and that is merely the lowest-hanging fruit in a forest of human-factor hazards.

But we don't tend to think on paper. We think in our heads, which Fischhoff has spent his working life trying to get into. In a 1978 paper titled "How Safe Is Safe Enough?" he and his coauthors noted that in modern industrial societies, "the benefits from technology must be paid for not only with money, but with lives." From nuclear energy to aerosol cans—and, of course, cars—"every technological advance carries some risks of adverse side effects." The question was: How much were people willing to pay in convenience, efficiency, and money to lessen that risk? The answer does not simply depend on the amount of benefit, but how we feel about the risk itself—and not all risks are felt with the same force.

Let us now flip the equation somewhat. Imagine that fully automated vehicles come to market with a promise of being safer than conventional automobiles and at a comparable price. What level of additional safety—rather than "acceptable risk," think "perceived benefit"—would prompt drivers (who rarely have immediately warmed to new safety technologies) to give up the wheel for good? Last year, Mark Rosekind, head of the National Highway Traffic Safety Administration at the time, declared that a driverless-vehicle fleet, to earn government approval, should increase safety at least twofold. In other words, it should at a minimum cut in half the current toll of roughly 40,200 deaths annually. Even that large of an improvement might not be enough to entice Americans to give up the steering wheel, though, since computer-driven cars push the very same psychological buttons that most strongly affect our feelings of risk.

Before considering the safety of driverless vehicles, it is worth determining how safe human driving is. The chance of any one trip in the U.S. ending in a fatality is remarkably small. In a 1978 study, Fischhoff estimated the odds at 1 in 3.5 million; after several decades of safety improvements, he roughly estimates the risk has halved, to 1 in 7 million. Over a lifetime, however, according to the National Safety Council, that figure drops to a mere 1 in 114 (with the proviso that one's individual risk may vary greatly). The disparity seems massive, but according to Fischhoff, people have trouble seeing "how small risks mount up through repeated exposure."

And so, even though driving has been called "the most important contributor to the danger of leaving home," few of us would openly admit to needing a car that drives for us. Simply being

a driver changes our risk assessment of driving. When the driver moves to the passenger seat, research has found, they become much less optimistic about their chances of not being in a crash. Suddenly, their risk has become more "involuntary." For us to become full-time passengers in a car, to accept that we are not in control, we will probably need commercial-aviation levels of safety, where the lifetime death rate is a mere 1 in 9821. No one much wonders anymore—given the extraordinary gains in aviation safety—whether man or machine is at the controls of their flight at any given moment. But to get us to that point, driverless cars will need an extraordinarily robust safety net.

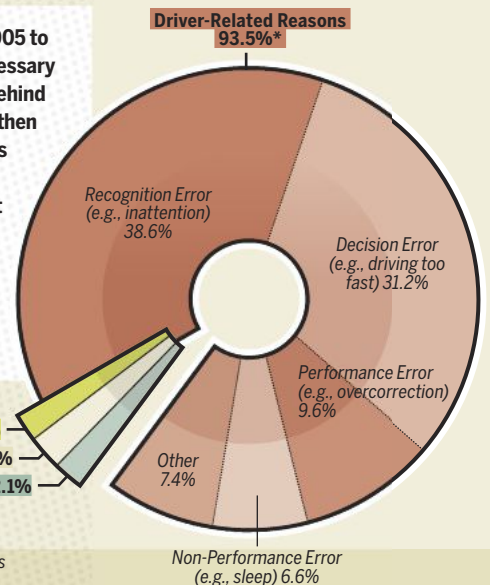
Feelings of risk decline when one feels in control. We so enjoy the feeling, laboratory studies have shown, that people will pay more to make their own choices—even when doing so comes with a greater risk of a bad outcome.

Gill Pratt, the CEO of the Toyota Research Institute (which investigates service robots as well as robots for the road), uses the example of motion sickness to describe that connection, that feeling of dominion the driver has over a car. "When a person is behind the wheel, they tend to get much less carsick than if someone is driving for them," he says. "At a very basic neurological level, you know that you get to control acceleration and how the car turns—when I turn left, I know that pretty soon my inner ear is going to feel me turning left." Passengers, lacking that direct interface, can feel at sea, in more ways than one.

Fully automated cars not only make us passengers (and hence more fearful), they put us under machine control. That turns a

Crash Stats _ From 2005 to 2007, NHTSA collected the necessary data to determine the causes behind motor-vehicle crashes. NHTSA then used its sample of 5470 crashes to model the reasons for the roughly 2.2 million crashes that occurred nationally over the same period. It demonstrates that a significant percentage of crashes isn't caused by human error.

Vehicle-Related Reasons 2.0%
Environmental-Related Reasons 2.4%
Unknown Reasons 2.1%



*Due to rounding, individual categories do not sum to 93.5 percent.

a safer car.

voluntary activity into something that feels less voluntary, making us more risk averse.

Anuj Pradhan, a research scientist at the University of Michigan's Transportation Research Institute, was riding in a Navya Arma, a French-made driverless bus, in Mcity, the institute's test facility, when the vehicle made a small series of juddering braking maneuvers. Out of the corner of his eye, Pradhan had seen "a tiny bird, a sparrow," fly in front of the vehicle, and its motion was picked up by the vehicle's lidar sensors. If he had not seen the bird, Pradhan says, he might have been tempted to yank the emergency shutoff—or what the researchers call the "Oh shit! bar." A driver might have explained the reason for the incident, but the machine simply resumed. "This is where the human-machine interface becomes critical," he says. "You want to be able to inform the passenger or operator what the state of the system is." Automation researchers have noted that where human relationships tend to build toward trust, our trust in machines begins high and then erodes with errors. We are more likely to give people second chances than machines.

"The rational utilitarian view is that we should trust the machines versus us as long as they're even the slightest bit better," says Toyota's Pratt. But how good will be good enough? "Our hypothesis is that, because it's hard to empathize with a machine compared with a person, society is going to hold machines to a higher standard," Pratt says. This not-level playing field could have legal ramifications, the authors of an article in the *Santa Clara Law Review* contend. Cost/benefit arguments, they suggest, would "not depend on whether the at-fault autonomous vehicle is better overall than a traditional vehicle, but whether the autonomous-vehicle technology could have been tweaked to make it safer." Computer-driven cars do not so much have to be better than people, but rather the platonic ideal of a driverless vehicle itself.

A machine-caused crash looms larger than a human-caused crash. As the English risk expert John Adams puts it, "What kills you matters." It matters in myriad ways. In one study, subjects were presented with two fatal crash scenarios: In the first, death was the result of "inhalation of toxic fumes from a damaged engine"; the second death came from "trauma caused by the force of the airbag deployment." Both were arguably product flaws, but under a dynamic termed "betrayal aversion," subjects felt much more betrayed by the manufacturer under the airbag condition because their trust was violated by the very thing that was supposed to save them. Driverless vehicles, marketed as a correction to human error, will have to overcome our low threshold for betrayal.

In "How Safe Is Safe Enough?" the authors wrote that "reduction of risk typically entails reduction of benefit." Traffic fatalities could be massively cut, virtually overnight, if speed governors set to 35 mph were installed on every car. We have decided that the benefits of fast, unfettered mobility are worth the cost in human lives.

Ian Walker, a psychologist specializing in traffic safety and travel choices at the University of Bath, says there is something else, besides the perceived benefit and the voluntary risk, that leads us to accept highway fatality numbers that far exceed workplace—even combat—deaths. And that is randomness. "Implicitly, people are buying into this idea that it's okay to have a system in which

"The rational utilitarian view is that we should trust the machines versus us as long as they're even the slightest bit better."

Gill Pratt,

**CEO of the Toyota
Research Institute**



millions of people die as long as there's no predictability or forethought about it." It is millions of drivers, driving millions of miles, making their own risk/reward decisions, having the occasional "accident"—a word we turn to for comfort, even though we know most accidents are preventable. More than a century after the invention of the automobile, with the true "auto" mobile shimmering on the edge of feasibility, the whole calculus of risk and safety will be taken out of the hands of individuals and brought into the system-wide decisions of software engineers, vehicle manufacturers, and regulators. Whether those parties favor absolute safety at the cost of convenience (with slower, less aggressive cars) or embrace the gains of machine optimality with higher risks (platoons of tightly packed, fast-moving vehicles) remains to be seen, but for the first time, the decision to assign odds will be made consciously. We'll no longer be gamblers but the casino. ✕

_ a patient, better driver.

Making a computer that drives more reliably than a human should be easy. Making a machine that can safely negotiate the chaos of our roads and still move at reasonable speeds—that's the hard part. But it will be essential if robocars are ever to co-exist with human drivers.

"[Humans] make quick judgments based on not a full analysis, and it gets us by most of the time," explains David Strayer, a professor of cognition and neural science at the University of Utah. "When we make decisions, we basically use a lot of short-cuts to get us to a good answer most of the time." In contrast, artificial-intelligence computer systems offer "kind of a brute-force analysis that pulls together a lot of different pieces of information."

Homo sapiens' faith, intuition, hope, altruism, and wild-ass guesses are precisely why human drivers can negotiate their environments at high speeds. Without the willingness to break rules and act with incomplete information, machines will struggle to make sense of our unpredictability. "The challenge right now is that autonomous cars tend to treat people as merely these obstacles that are in the way, and they try to be very careful about not colliding with them," says Anca Dragan, who runs the InterACT Lab at the University of California, Berkeley, which investigates the interactions of humans and robots. "This leads to trouble because people can take advantage of this defensiveness." In other words, given the cautious, law-abiding behavior of a driverless car, we malicious humans can game that vulnerability for our own commuting advantage.

Eventually, though, computers may process their environment in a way we can't comprehend. "The new thinking, which is still evolving, is this 'deep learning' stuff," Strayer continues. "The computers actually develop their own algorithms and tune themselves to make good decisions. They've been very impressive and able to outperform humans in many respects. [Deep learning] has the potential to be very powerful and very effective. But unfortunately, we may not ever really be able to understand what it does. It's effectively a black box, impenetrable to us. It will be abstractly representing the problem space in a way we may not need to know, but I don't think we could know if we wanted to."

These deep-learning machines could eventually resemble our own limbic-system lizard brain, which is largely unknown to us but saves our bacon in many situations. Before computers can master the craft of driving, though, they will need to become more human. —John Pearley Huffman







We're not waiting for the future. We're creating it.

As humans, we're conditioned to resist change.

We're creatures of habit who find comfort in what we know.

But a revolution in automotive intelligence is coming.

It promises to shake up industries,
rewrite social contracts and transform the way we live.

In short, it will change everything. And that's good.

Has the status quo ever given you goosebumps?

Of course not. Only change can do that.

That's why Audi has been a leader in the development
of automated driving for over a decade.

It's why we're on the cusp of launching models with varying
levels of this technology in the years to come.

As the technology progresses, we'll focus on safety with the
same attention to detail that made us who we are today.

Because we know change can be daunting,
but that never stopped us before.

Progress is rising to every challenge.



Can a connected car ever be safe from hacking?



The nation's rock-star hacker weighs in on the vulnerabilities of shared, internet-connected, computer-piloted cars—and is distressingly positive about the whole thing. _ by Jared Gall

Charlie Miller

made headlines in 2015 when he and another cybersecurity researcher, Chris Valasek, remotely hacked into a Jeep Cherokee as it was being driven down the highway for a story in *Wired* maga-

zine. (The Cherokee's driver, a *Wired* writer, knew what was happening.) Having made no prior physical contact with the vehicle, Miller and Valasek used the Jeep's Uconnect cellular connection to access its computers and take control of its acceleration, braking, and, during a later test, even its steering—all from Miller's couch. The most chilling aspect of the attack? It would have worked on any vehicle in the United States running that version of the Uconnect software. Their findings led to a recall of 1.4 million Chrysler, Dodge, Jeep, and Ram vehicles to have the vulnerability rectified. Miller has led driverless-vehicle cybersecurity at Uber, and both he and Valasek recently accepted positions with Cruise Automation, the GM subsidiary focused on the development of computer-driven cars.

C/D: Do you see a clear path to truly securing a shared driverless car?

CM: Yeah, for sure. I mean, that's my job, to do just that. If I can't do that, we're in trouble. There's nothing special about the computers that autonomous cars are using, the hardware, or the software. None of that stuff is fundamentally different security-wise than securing networks or computers that are sitting in a corporate network. The only difference is that, if you mess up and a hacker gets in, the consequences are much more severe. But no new defensive techniques need to be invented. We just need to systematically apply what we know, take our time, and do it right.

■ **That sounds fair enough, but you've read the headlines. So many companies and government entities fail to secure their**

networks. Are they simply failing to implement these best practices?

□ It's a little different than that. In some respects, securing a car is easier than securing a network of 20,000 laptops run by 20,000 people who are carrying them around, going to coffee shops, clicking on things, and surfing the web. A car at least is predictable. It's still a lot of computers, but they're used in predictable ways and we have a lot of control over the environment.

■ **But as we advance toward new ownership models, we'll have countless people with direct access to shared cars.**

□ For sure. People will have access to the vehicle for extended periods of time, and you need to design security into that. But the advantage you have is that, unlike a car company that's making a car and has to secure it, if you're

talking about autonomous cars run by ride-sharing firms, you've got cars that come home at night. We can examine them, check them, and update them. Where a normal car company sells a car it may never see again, we will have the advantage of knowing where the cars are. So we can monitor them and bring them in, we can update them whenever we feel like it, we can add new hardware. There are a lot of things we can do to help ourselves.

■ **In a full-on connected-car future, wouldn't you have assorted vulnerabilities in the infrastructure as well?**

□ Well, presumably the infrastructure would all be talking to each other, and so each device is a potential point of attack. But the car's computer needs to be smart enough to use multiple sources of data. You never want to rely completely on one sensor or one type of data.

■ **Is it realistic or even necessary to adopt a set of standards to regulate the implementation of these practices and technologies?**

□ Standards are one thing and might be helpful to make sure everybody is doing at least the right general things, but in the end, it's going to come down to each particular automaker and supplier doing everything right, checking each other, testing things, and getting third-party validation. Standards definitely are not going to solve the problem but might be the first step in the right direction.

■ **Is it reasonable to fear hackers taking control of the whole fleet and, say, have all cars make a 90-degree left simultaneously?**

□ We could have done that in the Jeep, so yeah, that's realistic.

■ **Could you have done it to multiple cars at the same time?**

☐ Absolutely. At any one time, all the cars that were on were vulnerable. Not all 1.4 million that were recalled are on at any given time, but all that were on [during our test], we could have scanned, found them, and made them do things. You could scan the internet, find them, and make them do things. It would take some preparation—you can't instantly scan and find 100,000 cars in one second, but you could scan over time, find them, and then once you knew where they were, and maybe you've programmed some part of your attack ahead of time, you could push a button and, yeah, they'd all do something.

■ **How long was it from when you got your hands on a Jeep to the time you were able to implement that hack?**

☐ It took a couple of months to even know there was a problem. But to get from end to end, where we exploited the vulnerability and we could do the most dangerous kinds of attacks, including turning the steering wheel at speed, that took close to two years. Of course, this wasn't our day job; we did it on weekends and evenings, so we could have gone faster. So maybe with more people . . . But in reality, it took close to two years, and so it's not something that some kids are going to do overnight or in a weekend. It is difficult, but at the same time, you don't ever want two guys in their basement to figure out how to do that.

■ **Are there any practical steps the industry should be taking that it isn't?**

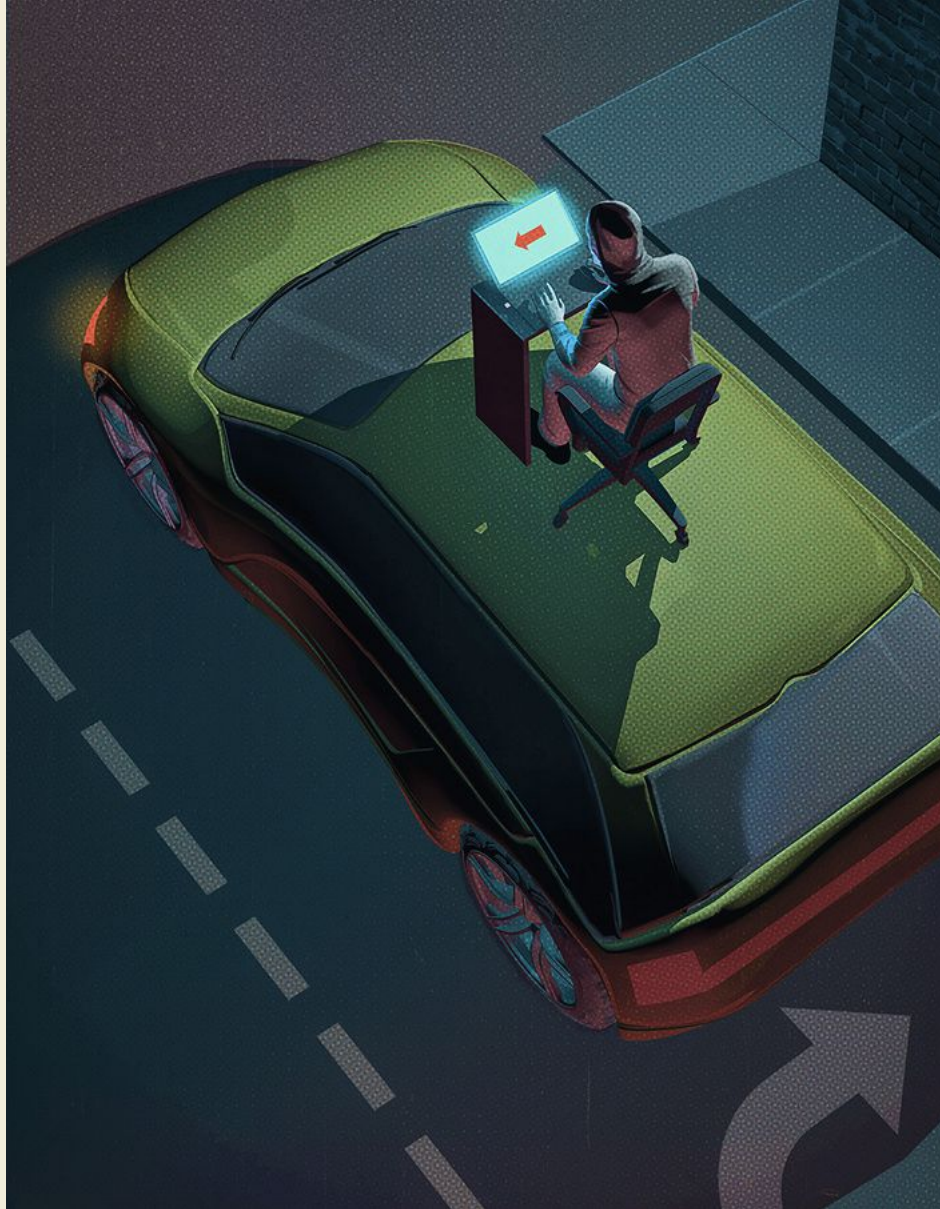
☐ The one I'd love to see is more transparency about what steps they are taking. They say they're working together, but I'd love to see academic people and researchers helping them as well. Security should not be a competitive advantage in any market, especially one that has to do with physical safety. The good news is, we're not going to have an autonomous car tomorrow or next week. Nobody knows when it's going to be, but we have time to get it right. We're in a good position now to do it.

■ **Is it possible to make a system unhackable?**

☐ No. Nobody knows how to do that. But what you can do is make it so hard that nobody cares enough to do it.

■ **But when the potential for mayhem is so high . . .**

☐ I guess. But when you make it so hard that only someone with a billion dollars can do it . . . A person with a billion dollars can cause a lot of mayhem in a lot of ways. Spending that to hack into autonomous cars probably isn't number one on that list. Hacking cars is hard. ✕



■ **Thinking Tank** _ The cybersecurity threat ratchets even higher when computer-driven vehicles go to war. **Dariusz Mikulski** is a ground-vehicle robotics research scientist for the U.S. Army Tank Automotive Research, Development, and Engineering Center, which plans to have driverless supply vehicles in war zones within 10 to 15 years. —Eric Tingwall

Q/D: **What's at stake if the military doesn't get cybersecurity right?**

DM: We have a lot of wireless devices . . . radios, radar, lidar, short-range and long-range communications, satellites, exposed ports, and we have supply-chain issues. We have a lot of different potential avenues that someone could exploit and have complete control of the entire vehicle.

■ **Does the threat change when you're fighting insurgents rather than a foreign government? Are they more or less capable of pulling off a cyber attack?**

☐ With cyber, there are low barriers to entry. People can learn it pretty easily. It's somewhat cheap to get involved in. That's not to say that it's easy to break into one of our systems. Even though there may be tools available and people may shop the knowledge, there's a lot of domain-specific knowledge that's not publicly available.

■ **If you can't make a computer system unhackable, what's the best defense?**

☐ The whole point of doing cybersecurity is that you want to create a bigger time buffer between when an adversary begins and when they actually get to your crown jewels. You want to make the time buffer so big that by the time they actually get to where they want to get, it doesn't matter anymore. The data is obsolete, it's irrelevant. If it takes an adversary six months to get into your system, but you can patch it in a couple of hours, that's a big win from a cybersecurity standpoint. ✕

What will Level 5 demand?

_ no longer afraid of the dark or midday shadows.

The tech:

Of all the challenges in putting a robocar on the road, figuring out the hardware may be the easy part. _ by David Beard

A Level 5 vehicle—a steering-wheel-less car in which the passenger is never a driver—needn't look like a koala-faced kid's toy with a chicken bucket fixed atop its roof. Supplier Continental, a key player in the technology involved in automated driving, imagines its compact and flush-mounted sensors can be adapted to fit the familiar shapes and styles of current cars. Can full automation be achieved with fewer sensors, such as Tesla's proposal to rely on a handful of cameras? "That's a tricky question," says Ibro Muharemovic, Continental's head of advanced engineering. Yes, one system could accomplish the task. For safety purposes, however, he says redundancy is key. Every system must have a fail-safe backup. Here's a look at the equipment Continental envisions enabling the highest level of automated driving:

■ Lidar

High-resolution lidar (light detection and ranging) sensors will map surrounding objects up to three football fields away with five-nanosecond bursts of laser that bounce back to the sensors, even through inclement weather or the dark of night. The compact sensors, which capture images of the environment in 30 milliseconds, have no moving parts, making them more durable and easier to discreetly integrate into a vehicle.

■ Ultrasonic sensors

Eight quarter-sized proximity sensors measure the distance between the vehicle and surrounding objects in low-speed situations and also provide cross-traffic information.

■ Radar

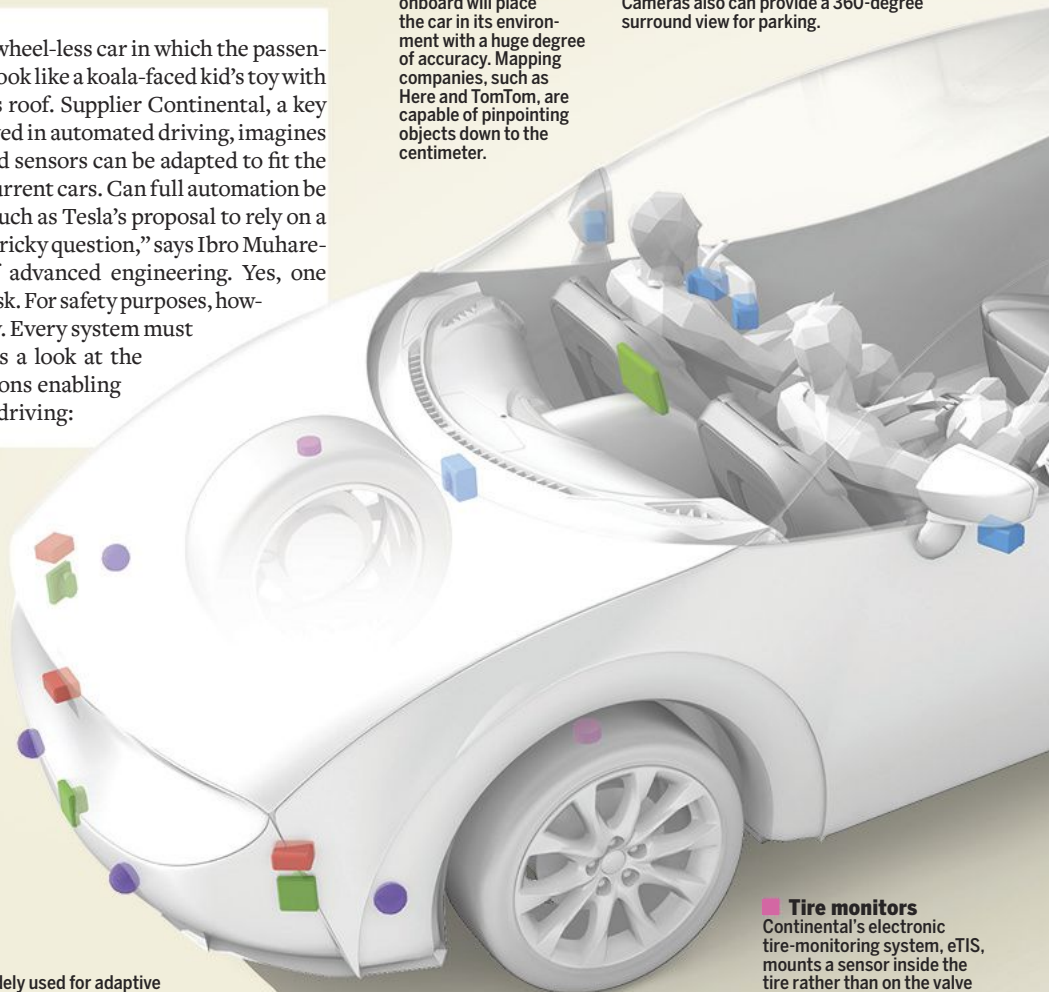
Already widely used for adaptive cruise control, radar sensors will be updated, changing from square to a more curved shape when applied to a car's corners, providing a wider field of view. Front radar units can look up to 900 feet ahead while rear sensors can see as far as 1800 feet to identify fast-approaching traffic.

■ High-definition mapping

Cross-referencing the information coming from the car's cameras and radar and lidar sensors with a high-definition map stored onboard will place the car in its environment with a huge degree of accuracy. Mapping companies, such as Here and TomTom, are capable of pinpointing objects down to the centimeter.

■ Cameras

Cameras—particularly depth-perceiving stereo cameras—mimic the human eye to monitor changing conditions, though they never blink or get distracted by a squirrel. That said, their daylight range is limited to roughly 300 feet compared with a human's 3000-foot visual acuity, so that will have to improve. Cameras also can provide a 360-degree surround view for parking.



■ Tire monitors

Continental's electronic tire-monitoring system, eTIS, mounts a sensor inside the tire rather than on the valve stem. This allows more accurate readings of tire temperature, load, balance, and even tread condition—information that will help the computer determine when it needs to increase following distances to leave more space for emergency braking.

■ Backup brake actuator

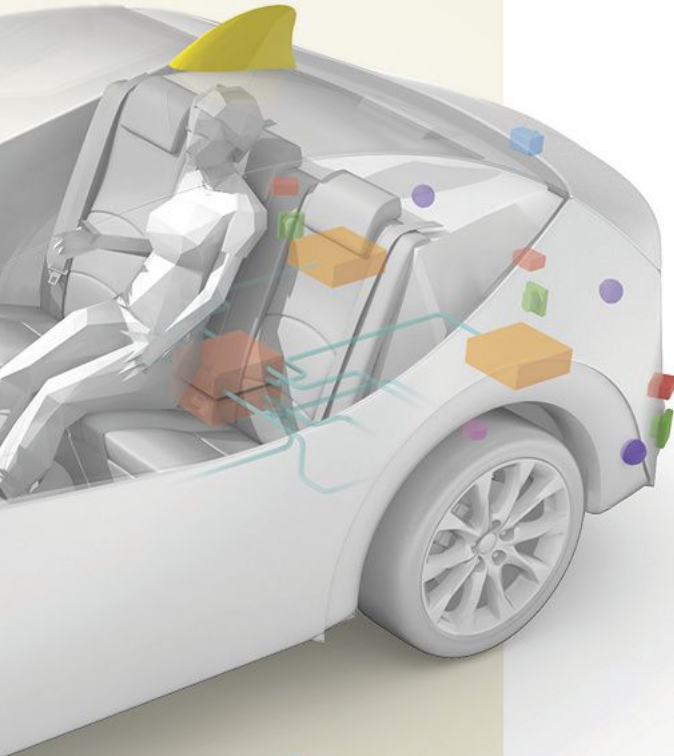
In case of a primary system failure, an emergency electronically controlled actuator will apply pressure to the hydraulic system to slow the vehicle.

V2X communications

Dedicated short-range radio frequencies can transmit live data more than 3000 feet from one vehicle to another (V2V) or to devices carried by pedestrians (V2P). Doubling down, information will also pass from vehicle to cloud and down to other vehicles via cellular networks (V2X), although nascent 5G technology, faster and with greater bandwidth than 4G, may be required to manage the data load.

Power supply

To hedge against an electrical failure, two distinct 12-volt circuits will power the system.

**The brains**

Continental's Assisted & Automated Drive Control Unit translates the many data streams into a real-time 360-degree digital re-creation of the vehicle's environment. The ADCU will then determine a safe path of travel and course of action, communicating that plan with the vehicle's drive, steering, and braking systems. Computing capability will vary depending on the visual requirements and redundancies of the systems, ranging from the power of a modern smartphone to that of six quad-core processors.

Information autobahn

Already in use for high-definition camera systems, Category 5 ethernet cables will quickly move data received from the sensors to the car's brains.

✕

illustration by Bryan Christie Design

The Level Playing Field _ Because no two automated-driving technologies are exactly alike, SAE International's standard J3016 defines six levels of automation for automakers, suppliers, and policymakers to use to classify a system's sophistication. The pivotal change occurs between Levels 2 and 3, when responsibility for monitoring the driving environment shifts from the driver to the system. —Eric Tingwall

Level 0 _ No automation

System capability: None. • **Driver involvement:** The human at the wheel steers, brakes, accelerates, and negotiates traffic. • **Examples:** A 1967 Porsche 911, a 2018 Kia Rio.

Level 1 _ Driver assistance

System capability: Under certain conditions, the car controls either the steering or the vehicle speed, but not both simultaneously. • **Driver involvement:** The driver performs all other aspects of driving and has full responsibility for monitoring the road and taking over if the assistance system fails to act appropriately. • **Example:** Adaptive cruise control.

Level 2 _ Partial automation

System capability: The car can steer, accelerate, and brake in certain circumstances. • **Driver involvement:** Tactical maneuvers such as responding to traffic signals or changing lanes largely fall to the driver, as does scanning for hazards. The driver may have to keep a hand on the wheel as a proxy for paying attention. • **Examples:** Audi Traffic Jam Assist, Cadillac Super Cruise, Mercedes-Benz Driver Assistance Systems, Tesla Autopilot, Volvo Pilot Assist.

Level 3 _ Conditional automation

System capability: In the right conditions, the car can manage most aspects of driving, including monitoring the environment. The system prompts the driver to intervene when it encounters a scenario it can't navigate. • **Driver involvement:** The driver must be available to take over at any time. • **Example:** Audi Traffic Jam Pilot.

Level 4 _ High automation

System capability: The car can operate without human input or oversight but only under select conditions defined by factors such as road type or geographic area. • **Driver involvement:** In a shared car restricted to a defined area, there may not be any. But in a privately owned Level 4 car, the driver might manage all driving duties on surface streets then become a passenger as the car enters a highway. • **Example:** Google's now-defunct Firefly pod-car prototype, which had neither pedals nor a steering wheel and was restricted to a top speed of 25 mph.

Level 5 _ Full automation

System capability: The driverless car can operate on any road and in any conditions a human driver could negotiate. • **Driver involvement:** Entering a destination. • **Example:** None yet, but Waymo—formerly Google's driverless-car project—is now using a fleet of 600 Chrysler Pacifica hybrids to develop its Level 5 tech for production. ✕

What will Level 5 demand?

— an empowered and informed member of society.

The regs:

— There aren't many now, and there aren't likely to be many in the near future.

— by Eric Tingwall

Earlier this fall, not long after Senate Republicans sank their party's seven-year assault on Obamacare, the House of Representatives did something almost unthinkable in the era of Congressional inaction. Two-hundred-and-forty Republicans and 194 Democrats voted unanimously to approve a bill. That bill did not propose a pay raise for Congress or publicly suggest Kim Jong-un suck on a uranium rod. It was actual policy.

Citing the potential safety benefits and economic payoff of robocars, House members established an early framework for driverless-vehicle regulations. Or, more accurately, they established that, in the near term, the rules will be few and far between for such vehicles. When it comes to future regulations in this area, lawmakers appear ready to let go of the steering wheel and hand over control to auto manufacturers and tech companies.

The crux of the SELF DRIVE Act (less coherently known as the Safely Ensuring Lives Future Deployment and Research in Vehicle Evolution Act) gives automakers the ability to request broad exemptions from the Federal Motor Vehicle Safety Standards to deploy their automated vehicles. The most obvious use for these exemptions is a vehicle without the mandated steering wheel and brake pedal, but Brad Stertz, Audi's director of government affairs, says automakers could also use their exemptions to steer around any of the regulations that were written with the assumption of a human driver at the wheel, such as those covering windshield defrosters and rearview mirrors.

While the proposed language will need to pass the Senate to become law, no legislator has publicly opposed the bill. In its current form, the bill allows an automaker to build as many as 25,000 nonconforming vehicles in the first year it receives an exemption. That allowance tops out at a maximum of 100,000 vehicles annually in the fourth year.

This largely hands-off approach is designed to let the technology drive the legislation, rather than vice versa. It's the same approach employed by NHTSA, the agency tasked with enforcing vehicle safety for features such as airbags and stability control. Early unregulated airbags that deployed with excessive, sometimes fatal force eventually led to the current mandate for smart systems that detect seatbelt usage and an occupant's weight. Legislators and regulators believe that any attempt to predict and circumvent those kinds of outcomes would only stifle development of a technology that has the potential to save hundreds of thousands of lives.

The House bill also blocks any state law that dictates the design, construction, or performance of what the feds call "highly automated vehicles." Manufacturers have openly complained for years that the nation's patchwork of state laws makes it difficult to develop and sell a car across the country. That fear likely would manifest as technical legalese rather than philosophical obstruction, as no state has passed legislation that is hostile toward driverless vehicles. At the moment, New York remains the biggest question mark due to a 1971 law that requires a driver to keep one hand on the steering wheel at all times while the car is in motion.

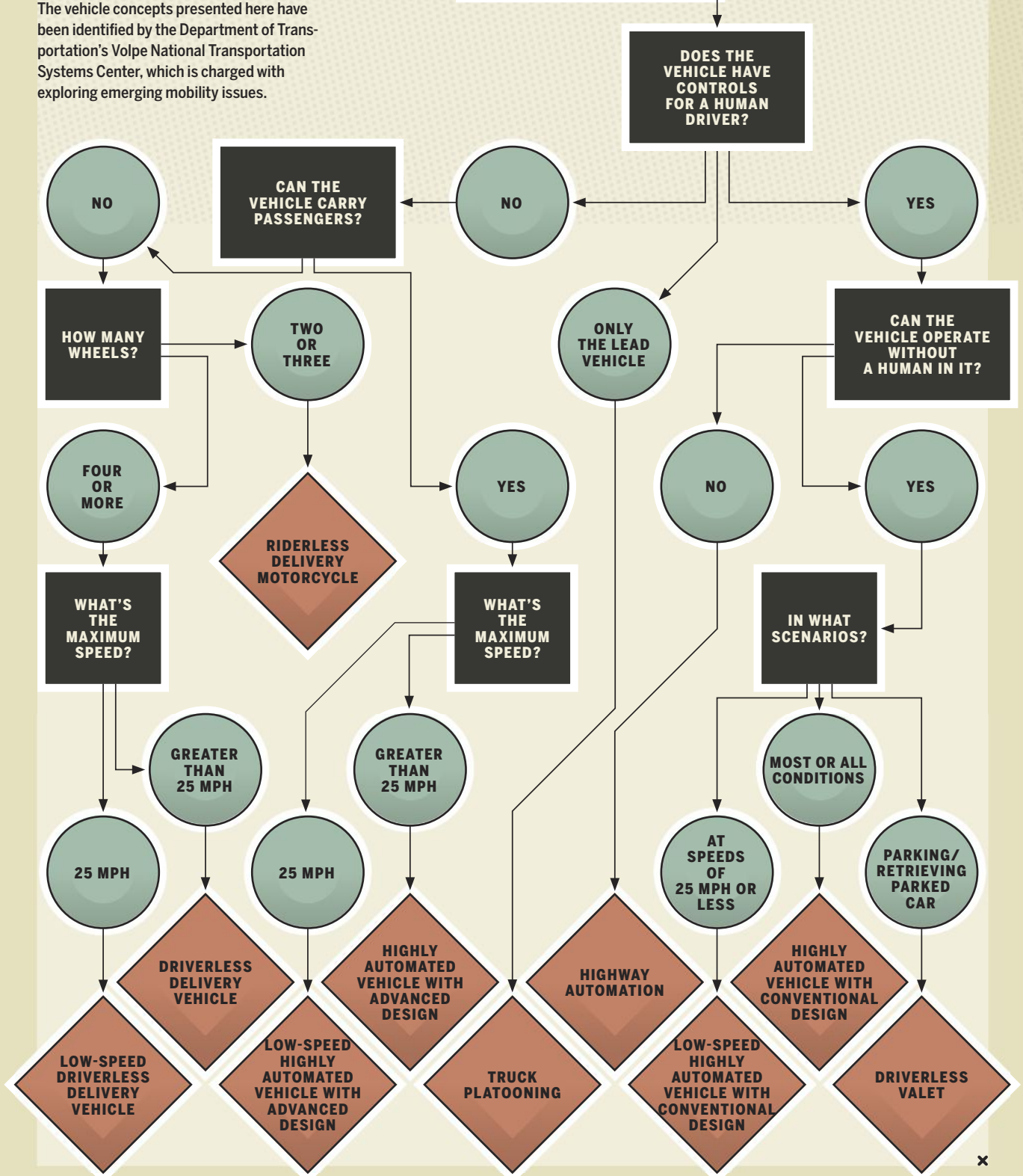
In large part, the SELF DRIVE Act should assuage companies' concerns that their science projects could be sidelined by legislators. Even with a green light to build outside the current regulations, though, manufacturers won't flood our roads with robocars the day after such a bill becomes law. "The conventional wisdom for years has been that automated vehicles are ready and that it's the law or lawyers that are holding them back, and that's empirically, demonstrably incorrect," says Bryant Walker Smith, an assistant professor of law and engineering at the University of South Carolina. "Developers of these systems aren't necessarily sure about their own technologies' applications or business cases. In some cases, they're not sure how safe is safe enough from an internal perspective, from a design perspective, and how they'll demonstrate that internally, much less externally."

In October 2016, Tesla announced that all its cars would be built with the hardware to support its Full Self-Driving Capability option. Buyers can prepay \$3000 for the feature with the expectation that Level 5 capability will be enabled with an over-the-air software update at an unspecified date. Tesla's website buys the company indefinite cover with a disclaimer: "Self-Driving functionality is dependent upon extensive software validation and regulatory approval, which may vary widely by jurisdiction." But given that any Tesla bought today abides by the FMVSS, that U.S. law operates with the presumption of legality, and that no state has intentionally blocked driverless vehicles, the regulations are largely a scapegoat at this point. The *Wall Street Journal* reports that more than a dozen members of Tesla's Auto-pilot team have left in recent months over rushed deadlines and reckless marketing decisions.

"I made a prediction a while back [of] the two things to look for to conclude that automated driving is truly imminent," Smith says. "The first is developers of these technologies saying specifically what legal changes, if any, they need to deploy." The House's SELF DRIVE Act is the first realization of those requests. Smith's second bellwether has yet to ring. "The other thing to look for is developers starting to say publicly what safety means to them and how they're going to ensure the safety of their systems." ✕

We tend to think of computer-driven cars as one of two forms: a futuristic pod with no driver controls or a conventional car with the ability to drive itself in certain situations. However, we're likely to see driverless vehicles in a variety of shapes, sizes, and uses if Level 5 technology comes to fruition. The vehicle concepts presented here have been identified by the Department of Transportation's Volpe National Transportation Systems Center, which is charged with exploring emerging mobility issues.

What form will the driverless vehicle take?



_ no chance of escape.

Where are we right now?

_ We go hands-off in four vehicles you can buy today to understand the current state of automated technology and why progress won't come easily. _ by Eric Tingwall

Let's make one thing clear up front: Until now, no automaker has endorsed drivers removing their hands from the steering wheel. The steering assists that have proliferated in recent years are all padded with liability disclaimers and hand-sensing algorithms that admonish drivers if they stop maintaining contact with the wheel. Yes, this is true even of Tesla's Autopilot, regardless of what you may have seen on YouTube. A can of Red Bull taped to the steering wheel as a substitute for a human hand is not a hack. It's a flaw in human intelligence.

In October, Cadillac claimed a notable first in the automation arms race when its truly hands-free Super Cruise technology reached showrooms. Available on the CT6, Super Cruise enables the car to sail down divided, limited-access highways at speeds up to 85 mph for as long as the driver's chosen lane lasts, no hands or energy-drink cans required. While Super Cruise represents the leading edge of partially automated technology in today's production cars, it reflects only one company's approach, and at \$71,290 for the cheapest CT6 with the feature, it won't change driving for the masses. The 2019 Audi A8, due in the United States this spring, has the potential to advance the game to Level 3, allowing drivers to take both their



The owner's manual says to keep your hands on the wheel at all times. But who reads the owner's manual?

hands off the wheel and their eyes off the road with its Traffic Jam Pilot. However, the company remains uncertain if it will enable the technology in the U.S. due to regulatory and liability concerns.

For a broad read of the current state of these technologies, we slipped behind the steering wheels of four vehicles on sale today and then handed control to the computers. These vehicles—a Tesla Model S with the company's second-generation system known as Enhanced Autopilot, a

Honda Civic with Honda Sensing, an Audi Q7 with Traffic Jam Assist, and the Super Cruisin' Caddy—represent a spectrum of philosophies, prices, and capabilities. A comparison test pitting the vehicles against one another was guaranteed to force some systems out of context. Instead, we evaluated the systems individually and according to their intended uses. And while we admit to taking our hands off the wheel in every vehicle, we insist it was only done in the service of journalism.



Tesla Enhanced Autopilot (Level 2)

A year after its debut, Tesla's Enhanced Autopilot still offers no perceivable enhancement over the first-generation Autopilot. Compared with the original, the second-generation hardware suite employs four times as many cameras, ultrasonic sensors with double the range, and 40 times the computing power, yet Enhanced Autopilot shipped in October 2016 without fundamental abilities such as self-steering and adaptive cruise control because Tesla was still developing the software. All the sensors in the world can't guide a car if the computer can't make sense of the world, and Tesla took a temporary backward step when it brought Autopilot development in-house after an ugly public breakup with Mobileye, the supplier behind the original Autopilot.

By this past August, when we shepherded a \$146,200 Model S P100D around Southern California, Enhanced Autopilot

operated at the same level as the first-gen system, both according to Tesla and our own observations. The self-steering algorithm is no more certain or reliable than the earlier version we lived with in our long-term 2015 Tesla Model S. The technology that oozed possibility two years ago now simply feels incomplete, especially since Enhanced Autopilot makes the same unsettling mistakes as its predecessor did—mistakes that suggest a Tesla can't always make sense of its environment.

Autopilot can cover hundreds of miles flawlessly or it can make a dozen errors in as many miles. In either case, we're always caught off guard when the system makes an abrupt steering input that attempts to yank the Model S out of its lane without warning. These errors appear to occur when Autopilot becomes confused about where the lane markers lie, either due to a groove in the road, a worn lane line, or the intentional interruption of markers when lanes merge



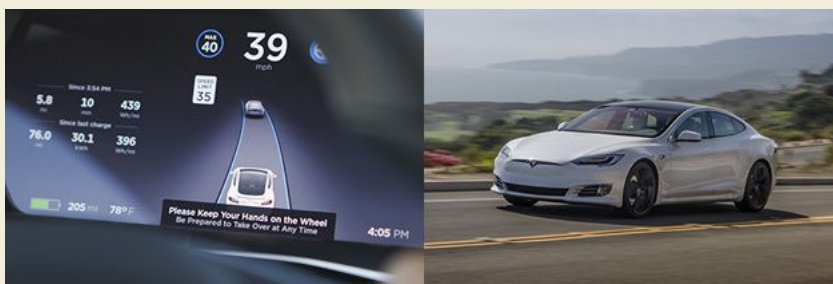
Tesla Model S with Enhanced Autopilot

Camera • Radar • Ultrasonic sensor

and split. A firm grip on the steering wheel is usually enough to keep the car in its lane and disable Autopilot in these instances, but an inattentive driver can find himself making an involuntary lane change. A better solution would be to simply hand control back to the driver.

The enhancements are coming, and we're told the current "beta" system will eventually evolve into Level 3 tech for highway driving. The company also promises that the sensors it installs in every new car it builds—eight cameras, a forward-facing radar, and 12 ultrasonic sensors—will be enough for Level 5 go-anywhere, hands-free automation with a software update. "You can absolutely be superhuman with just cameras," CEO Elon Musk claims.

But even a mediocre human still has an advantage over today's Autopilot. The cameras can't don sunglasses, flip a visor down, stretch a hand out, or crane a neck to cope with the glare when the evening sun



Tesla's Autopilot user interface gives the driver the most complete picture of how its computer interprets the driving environment, including curved roads, adjacent lanes, and nearby vehicles.

_ slower and more calculated.



dips toward the horizon. Pointed west, the car ping-pongs within its lane as it sniffs for the markers. Later, darkness paints over the grooves, cracks, and faded remnants of no-longer-used lane lines that are Autopilot's kryptonite. With less noise to filter out, the Model S centers itself in its lane and glides down the 101 as smoothly as we've ever experienced.

_ Honda Sensing (Level 1)

There will be no automation revolution as long as the technology is priced for the coastal crust. As a \$1,000 add-on (and even standard on certain models), Honda Sensing sells for one-fifth of Tesla's Autopilot option, and it can be had on a Civic LX sedan at a price as low as \$21,415.

With limited authority to make steering inputs, Honda's suite behaves more like a driver-assistance feature than a partially automated system. Still, Honda Sensing stands out among other affordably priced alternatives because it performs lane-centering, a more graceful variation of the lane-keeping assists that typically kick in with imprecise steering inputs only as a vehicle is about to leave its lane. The Civic Touring we drove traced a steady line on

straight sections of highway with the driver offering only a limp handshake to the wheel. Yet Honda Sensing only nudges the steering wheel in the right direction when the road bends, and the driver must add more lock at turn-in to keep the car from running wide.

It's a similar situation with Honda's adaptive cruise control: If you don't play an active role in the driving, you stand to be burned. While most industry players have mastered radar cruise control, Honda's system occasionally fails to register the appropriate bogey from which to base its speed when vehicles change lanes. Around gradual bends, Honda Sensing can fail to spot the car it's closing on until the Civic is practically on top of it. And in the hairiest scenarios, the system doesn't always brake hard enough to avoid a collision. It's up to the



Honda's user interface shows the minimum information to convince the driver the system has a read on the situation. The lane-centering function makes only modest steering inputs.



_ Honda Civic with Honda Sensing

■ Camera • Radar

driver to intervene or else end up in someone's trunk. And while Honda Sensing routinely does bring the vehicle to a stop in the normal flow of traffic, the adaptive cruise control requires the driver to tap the right pedal or the RES button to accelerate again.

Are these technical limitations or a product of risk-averse Japanese culture? Do the Honda's shortcomings stem from inexperience or a conscious acknowledgment that the more adept the self-steering system, the more likely it is to inspire false confidence? The low-cost Honda Sensing system gives us the feeling that all these factors are in play here.

_ Audi Traffic Jam Assist (Level 2)

Taking the misery out of masochistic commutes is the killer app for budding automation. The relatively orderly highway environment constrains the technical problem while the low speeds of congestion minimize the risks if things go awry. That's exactly the philosophy behind Audi's Traffic Jam Assist, which is intended for use on limited-access roads when traffic drags below 40 mph. Those restrictions reduce the system's usefulness if you're crossing Middle America, but anyone who has braved L.A.'s 405 at 5:00 p.m. recognizes the value in relieving the driver from the grinding tedium of a rush-hour slog.

Scanning the world with a single camera behind the windshield and two radar sensors in the lower fascia, Traffic Jam Assist manages speed and steering, choosing its path by considering both the lane markings and the vehicle ahead of it. We sampled Audi's tech in a \$75,655 Q7 on Michigan freeways snarled by construction and the morning rush in the kind of stop-and-go that has every driver staring into his or her lap. With Traffic Jam Assist effortlessly gliding along, the magnetic suck of an idle smartphone is even stronger, but Audi expects the driver to remain alert with hands on the steering wheel. The system allows the driver just eight seconds of hands-off time before the chimes start and, if the driver doesn't resume control, slows the vehicle to a stop 10 seconds later.

The 2019 A8 will silence the steering nanny and evolve Traffic Jam Assist into Traffic Jam Pilot—it's just a matter of whether or not that technology is enabled.



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Audi Q7 with Traffic Jam Assist

Camera • Radar



Audi's Traffic Jam Assist telltale is little more than a status indicator. At the relatively low speeds of stop-and-go traffic, it's tempting to let the computer do its thing with no oversight.

In markets where Traffic Jam Pilot is turned on, Audi will likely be the first automaker with Level 3 technology in production. That permits not only hands-free driving but eyes-off-the-road operation during highway traffic jams. Audi will even allow the driver to watch videos on the car's infotainment display when the system is active. That's preferable to napping because Traffic Jam Pilot needs the driver on standby to merge when the lane ends, steer around a disabled vehicle, or take control when traffic accelerates beyond 37 mph. This relatively low speed limit assures the lawyers that the computer can identify any showstoppers with enough time to alert the driver and safely hand over control—or, at the very least, bring the vehicle to a stop in traffic

conditions where such behavior wouldn't be totally unexpected.

Turning up the speed is the next logical move, but doing so exacerbates the hand-off problem that makes many automakers reluctant to introduce Level 3 automation for open-road driving. A car covers more than 100 feet every second at 70 mph, and any system that relies on a human to step in to solve the edge-case scenarios that stump the computer will have to provide adequate warning time for the driver to orient himself and understand the situation.



If All Goes According to Plan . . . Here are carmakers' on-the-record timing for their automated products.

2017

_ Audi will launch Level 3 tech for use on congested highways at speeds up to 37 mph.

2020

_ Audi will build Level 4 vehicles.
_ Daimler will release Level 4 taxis in select cities "by the beginning of the next decade."
_ Honda vehicles will have Level 3 capability for highway use.
_ Hyundai will sell vehicles with Level 3 highway capability.
_ Nissan ProPilot will offer Level 4 city driving.
_ Toyota's Highway Teammate will deliver Level 3 capability.

2021

_ BMW will release its fully automated flagship model, iNext.
_ Ford will produce Level 4 vehicles without steering wheels or pedals for ride-hailing services.
_ Volvo will offer Level 4 cars for sale.

2025

_ Honda will offer Level 4 capability for use in most driving situations.
_ Nissan will introduce Level 5 driverless vehicles.

2030

_ Kia will put fully automated vehicles on the road. x



Cadillac Super Cruise (Level 2)

While Super Cruise's maximum speed matches the speed limit of America's fastest highways, it steers around the hand-off problem by forcing the driver to keep his eyes on the road. Super Cruise remains a Level 2 technology for this specific reason; Cadillac requires the driver to maintain vigilance, scanning for hazards even as the car takes over the physical act of driving. To ensure that the driver's focus doesn't stray, an infrared camera tracks his eyes from atop the steering column.

With the main cruise-control function enabled, a gray steering-wheel icon appears in the gauge cluster when Super Cruise is available. A tap of the Super Cruise button on the left spoke activates the system, the light bar on the steering wheel glows green, and the car glues itself to the center of its lane. High-definition maps of all 160,000 miles of divided U.S. highways (updated quarterly via a cellular-network download) and a GPS antenna that's accurate to six feet help the CT6 pin-



Cadillac's clever light bar glows green when Super Cruise is active and flashes red when the driver needs to pay attention to the road. A blue light indicates the driver has taken control.

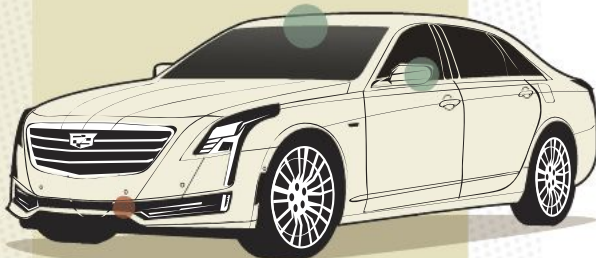
_ at a better pace.

point its exact location in the physical world. This allows Cadillac to alert the driver when the chosen lane is ending long before the cameras could ever know. Steer onto an exit ramp and Super Cruise immediately kicks control back to the driver. Park it in the right lane, though, and Super Cruise could seemingly track forever. In 40 miles of driving, the system didn't ask us to take the wheel, except when we intentionally aggravated it by looking away from the road for an extended period. After less than 10 minutes, Super Cruise's rock-steady competence became boring.

Cadillac's challenge now is to keep the driver's eyes and attention on the road when his hands and feet are idle. Super Cruise's cameras and radars won't detect a construction barrel nudged into the lane—or lined up squarely with the Cadillac crest for that matter. They won't spot a pothole in the road, or tire tread, or any number of small objects capable of inflicting damage. That's all on the driver.

Super Cruise's eye-tracking camera can see through most sunglasses, but in the rare cases where it can't, it infers eye position from the driver's nose, mouth, and general head position. Drop your eyes to read an email or hold your phone up in front of your face, and in less than 10 seconds, Super Cruise will call on you to grab the wheel. Don't respond, and the car will eventually begin coasting to a stop.

While Audi sees higher speeds as the larger threat, Cadillac is reluctant to take responsibility for seeing and understanding everything happening around the car. Level 3 automation at Super Cruise speeds raises the stakes exponentially and CT6 chief engineer Lyndon Lie admits that the next step is not a step at all, but a leap. If there's an obvious way to let the driver check out at 70 or 85 mph, he's not telling us. ✕



_ Cadillac CT6 with Super Cruise

Camera • Radar



Can Semi-Automated and Fully Automated Cars Coexist? _ It's assumed that technological progress in semi-automated cars will terminate in the fully computer-driven machine, and both will need to interact with each other. But is this necessarily the case? Can humans and machines peacefully share the road, and can engineers and programmers figure out how to make that work?

Dr. Alexander Hars is a former business professor at the University of Southern California and the founder of Inventivio GmbH, which provides consulting services to companies working on driverless mobility. We asked him to explain how it might all come together. —Clifford Atiyeh

C&D: How can fully computer-driven cars truly coexist with human-driven ones?

AH: I think that the question of full autonomy is one that you should not see as a self-driving car driving everywhere in the world. In the early stages of full autonomy, it's likely that fully autonomous vehicles will drive only on known streets, only in areas where we know they can operate. If you look at Waymo in Phoenix, this is exactly what they are doing. There is no reason why we should expect this not to work in the next couple of years.

■ **Humans are very unpredictable, even with fully automated cars confined to one area.**

Can the lofty goal of near-zero fatalities be achieved with drivers still in the picture?

□ Driving is not a creative act. If we think about what's going on, this is information processing. You need to know your environment, you need to understand how the different traffic participants typically behave, to calculate, to predict to a certain extent, but fundamentally it's information processing, some-

thing computers are good at. They err on the side of caution. It will only be possible to let self-driving cars on the road when they are substantially safer than humans, otherwise they would have to make so many obvious mistakes that people would revolt immediately.

■ **Some automakers have said it will be harder to realize Level 3 automation, which would require human intervention at a moment's notice, rather than Level 5, which would never involve a driver. What do you think?**

□ Level 3 is fundamentally a wrong idea. It's very difficult; it decreases safety because it makes driving much more complicated. You have the whole interfacing problem between human and machine, the idea that humans are vigilant. Every safety expert will tell you there's one thing that humans are not good at: paying attention to something, supervising something for a longer time. It's just impossible. Level 3 should be avoided and [we should] go directly to Levels 4 and 5. ✕

nothing so ridiculously teenage and desperate.

Who's at fault?

The road to full automation will bring several lifetimes' worth of work for lawyers. — Jeff Sabatini

Somewhere way off in a future California, a line of 35 computer-driven cars is trundling up Interstate 5 in a tight, wind-cheating formation at 110 mph, each car a mere two inches off the bumper of the preceding car. Now let's say a tire blows on car 17, or an electronic glitch befalls car 7 and it locks a wheel. Passengers will be rudely awakened from their intravenous-doughnut haze, their quadruple lattes doing the old abstract impressionist bit on the headliner. Let's hope everyone's safe.

Or imagine a computer-controlled vehicle puttering around a city, with no one at the wheel, slowing down to pick up a passenger. Then, because of an insecure network, the car gets hacked by the Brotherhood for Authentic Mexican Cuisine, and it sails past the loading zone, whizzing at high speed into the nearby Chipotle. Or imagine a bird sails into the sensor array of a Level 5 vehicle, knocking into the car's ability to see. Mayhem ensues.

Who is to blame? Who gets sued in these scenarios? The tire company? The software maker? The drivers who touched "Agree" on their startup screens? In all cases, we appear to be exchanging one set of understood risks for another more opaque sort. And the implications of these new risks will need to be figured out before driverless cars can operate in the real world.

Automation seems destined to shift this blame from individual drivers onto carmakers or equipment manufacturers, which are characteristically wary of assuming that liability. But law is often based on precedent, and at the moment, there has been precious little litigation dealing directly with robocar crashes. The most infamous case is not even a case yet, as the family of Joshua Brown, the driver killed in May 2016 when his Tesla Model S operating in Autopilot mode struck a semi that crossed its path, has yet to file a lawsuit. But Brown's crash—the first death attributable at least in part to automated-vehicle technology—can illustrate the complexity in assigning blame in these situations.

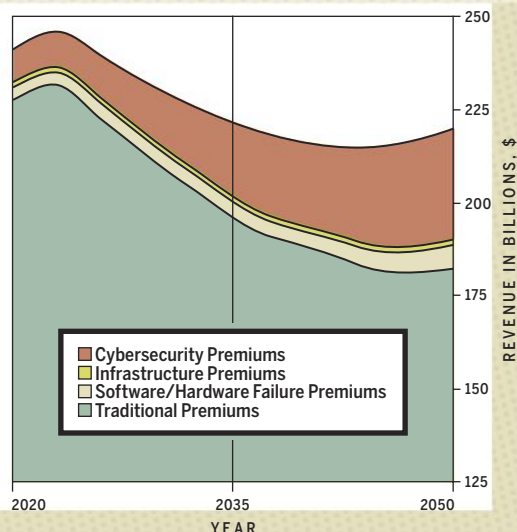
Tesla already has been seemingly exonerated by three investigations, one by NHTSA, another by the Florida Highway Patrol, and the last by the National Transportation Safety Board. The reports conclude that the Level 2 Autopilot and automatic emergency braking systems in the Tesla worked as designed and that Brown did not heed Tesla's general warnings about driver vigilance while using the technology. According to the NTSB report, Brown responded to the system's specific alerts to take control in a minimal fashion, touching the wheel for a total of 25 seconds during the 37-minute period that the car was under Autopilot control. Yet these findings do not preclude

Brown's family from suing in state court and alleging that Tesla bears some responsibility for the crash.

This access to the court system is one of the foundations of our current framework of product liability, one that many legal experts believe is capable of adapting to this new technology. Proponents of letting the courts sort out the liability issues involving vehicle automation point out that tort law—the redress of harms—has a long track record of managing the complex interactions between humans and the machines we create. These laws have provided strong financial incentives for companies to innovate while still prioritizing the safety of their products, from automated elevators to airplane autopilot systems to industrial robots. But concerns that corporate liability fears might delay the introduction of potentially life-saving driverless technologies have given rise to alternative theories of liability to preempt the tort system.

For now, however, determining fault in crashes involving Level 2 vehicles such as Brown's Model S will likely hinge on manufacturers arguing that drivers who are relying on these

Risk Shift — This year, consulting company Accenture, together with the Stevens Institute of Technology, published a report stating that the proliferation of computer-driven vehicles will reduce the number of traditional insurance policies and their cost, cutting revenue for insurance companies. The report predicts that insurers will compensate with the addition of cybersecurity, product (software/hardware) liability, and infrastructure policies sold to automated-vehicle OEMs and suppliers, tech companies, and government agencies.





systems are misusing them. Indeed, even Level 3 vehicles will operate autonomously in such narrowly defined circumstances that responsibility for crashes likely will be handed off to the human just as the car itself hands off control to the driver when those requirements for driverless operation are no longer met. Yet Brown's attorney still could counter with a number of arguments: that Tesla was negligent in its design of a system that did not shut itself off after repeated warnings to the driver were ignored; that Tesla misrepresented the capabilities of the Autopilot feature, implying even in its name that the system could function like that of a Level 3 or even Level 4 vehicle; or that Tesla should be held strictly liable, meaning that the inherent danger of its Autopilot system automatically implicates the company. Similar arguments will no doubt be made in court as driverless-vehicle technologies proliferate.

Safety and its attendant liability are such concerns in this burgeoning industry that some manufacturers have disavowed Level 3 vehicles. They have concluded that partial automation is potentially worse than none at all, because humans are ill-suited to take over the controls in the sorts of potentially dangerous situations in which a semi-automated system would abdicate its authority. This rift in the marketplace seems ripe for lawyers to probe.

That is, assuming they get their chance. Advocates for tort reform have suggested that federal regulations for computer-controlled vehicles might supersede the state courts, establishing one set of requirements for manufacturers to meet in order to shield them from liability lawsuits. Other proposed remedies include no-fault insurance and an accident compensation fund. Legal experts have also suggested that a cost/benefit approach to liability cases involving driverless vehicles might weigh whatever harms are claimed against the numbers of crashes (and deaths) prevented by the technology, thereby reducing manufacturer liability and tipping the scales of justice toward the larger public benefit. In the final analysis, it will be incumbent on manufacturers and automotive suppliers to make their systems as bulletproof as possible, if not for their own bottom lines, then to engender user trust. Expect more run-flat tires in our future. ✕



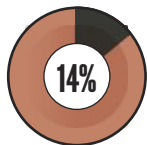
_ favors for favors.

Does Tesla's Autopilot Reduce Crashes?

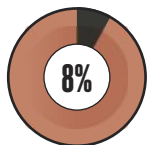
_ It depends on where you get your data.

Projected Fitment Rate for 2017 Global Passenger-Vehicle Production

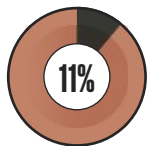
_ Automated emergency braking



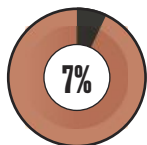
_ Lane-keeping assist



_ Blind-spot monitoring



_ Adaptive cruise control



_ Data provided by IHS Markit.

Joshua Brown's fatal crash, in which both Brown and his Tesla's Autopilot system failed to brake for a semi truck that crossed the car's path, highlights the crucial question hanging over the middle ground between human drivers and computer-controlled cars: Can active safety systems make driving safer without making driver behavior less safe?

In the case of Autopilot, only Tesla knows the answer, as the company holds the digital keys to the torrents of data beamed back to its headquarters from its cars. When NHTSA's Office of Defects Investigation studied the 2014–2016 Model S and 2016 Model X, it concluded that Tesla drivers crashed 38 percent less often after installing Autosteer, the lane-centering feature of Autopilot. But that report merely reviewed mileage and airbag deployment data, which Tesla supplied.

Insurance companies—a sorry proxy for third-party oversight—aren't convinced Tesla drivers are any safer than the rest of us plebes. In June, AAA—after reviewing a report by the Highway Loss Data Institute on vehicle insurance claims—said it would raise premiums for Tesla owners due to higher-than-average claim frequency and costs. In fact, the data shows rear-drive Model S owners made 46 percent more claims on average than owners of other passenger vehicles. Of course, that says nothing of causation, making it impossible to blame Autopilot instead of, say, the thrill of time-warping acceleration overcoming better judgment.

Looking at the broader industry, there is consensus that certain driver-assist systems reduce crash rates. According to the latest study of police-reported crashes by the HLDI, drivers of vehicles with forward-collision alert were 27 percent less likely to rear-end another car than those without the system—and 50 percent less likely if equipped with both forward-collision alert and automated emergency braking. If every car on the road had been similarly equipped with these systems in 2014, the HLDI estimates we could have avoided 400,000 injuries and 1 million crashes.

But there's no definitive evidence that lane-keeping systems—which people often switch off—reduce crashes. "We expected a lot of benefit from those, yet we didn't see it in the insurance data," says Matt Moore, senior vice president of the HLDI.

The biggest obstacle is the data itself, which only looks at reported incidents. Without continuous real-time information from every car, we can't be certain that driver-assist functions work correctly, prevent actual crashes, or are even activated. Moore says that event-data recorders—the black boxes inside most new vehicles that record variables such as speed and steering angle before a crash—need to capture a denser set of information if we're ever to answer this question. If that's the case, maybe these questions are best left unanswered. —Clifford Atiyeh

The One Simple Reason No One Is Talking Realistically About Driverless Cars

Researchers say that driverless vehicles, in order to be consumer-ready, need to be driven 11 billion miles in simulated or real-world settings. Let's put that number into perspective: In the eight years that industry-leading Waymo (formerly the Google driverless-car program) has been testing automated vehicles, it says it has driven just 3 million miles on public roads. But the company also claims that it recorded a billion simulated miles in 2016 alone, so maybe the finish line isn't so far away.

But what race, exactly, is it running? Are conventional car companies chasing Waymo, or are they in a different contest? Audi says its Level 3 system, Traffic Jam Pilot, will arrive with the 2019 A8, but whether we'll see that technology in the U.S. remains to be seen. Daimler has promised driverless cars by 2020, Ford by 2021, and others have made their own, similar forecasts. But what gets under-reported in coverage of these pledges is that both Daimler and Ford are talking about producing fleets of ride-hailing cars rather than privately owned, go-anywhere vehicles. What about Tesla, a carmaker that acts more like a tech company and has a stock

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will not cry in public.

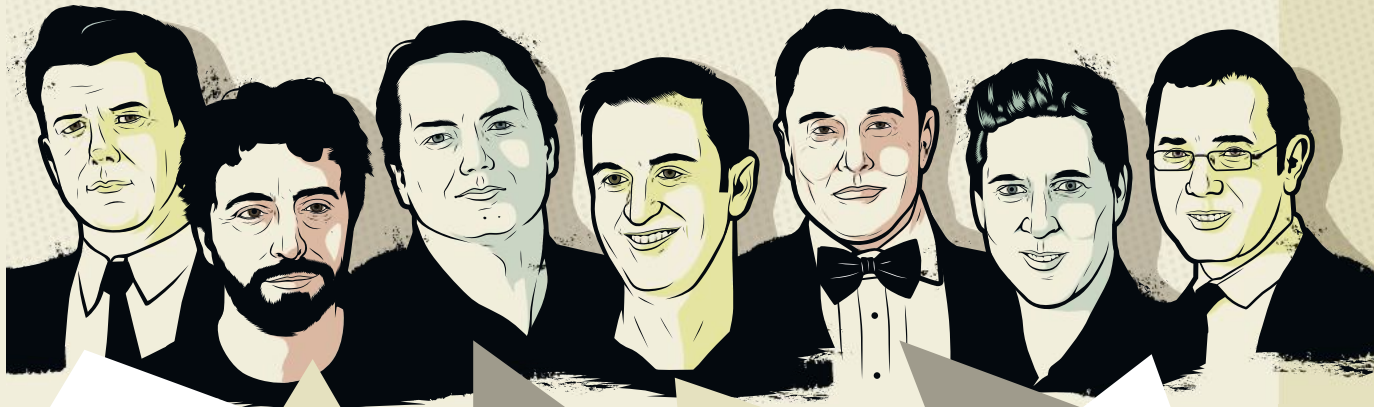
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valuation that makes every automotive CEO jealous? It's already selling "Full Self-Driving hardware" on its vehicles, but without the software, a practice for which it has been served a class-action lawsuit. There are more questions than answers here.

Paramount among them is this: If the driverless economy is imminent, and the endgame is fleets of fully utilized robot vehicles that create radical reductions in personal vehicle ownership, why would a car company be complicit in undermining its own market? The answer is that it wouldn't. No car company actually expects the futuristic, crash-free utopia of streets packed with Level 5 driverless vehicles to transpire anytime soon, nor for decades. But they do want to be taken seriously by Wall Street as well as stir up the imaginations of a public increasingly disinterested in driving. And in the meantime, they hope to sell lots of vehicles with the latest sophisticated driver-assistance technology. —Jeff Sabatini

Hype Machine

The Most Outrageous Predictions Issued on the Subject of Driverless Cars



"But these cars of 1960 and the highways on which they drive will have in them devices which will correct the faults of human beings as drivers. They will prevent the driver from committing errors. They will prevent his turning out into traffic except when he should. They will aid him in passing through intersections without slowing down or causing anyone else to do so and without endangering himself to others."

— Norman Bel Geddes, industrial designer behind GM's 1939 Futurama exhibit, in his 1940 book, *Magic Motorways*

"My oldest son is 11 and that means in four and a half years, he's going to be able to get his driver's license. My team and I are committed to making sure that doesn't happen."

— Chris Urmsen, then-director of driverless cars at Google X, March 2015

"By 2025, private car ownership will all but end in major U.S. cities."

— John Zimmer, Lyft cofounder, September 2016

"Almost all [new] cars built will be capable of full autonomy in about 10 years."

— Elon Musk, Tesla CEO, February 2017

"By 2030, within 10 years of regulatory approval of fully autonomous vehicles, 95 percent of all U.S. passenger miles will be served by transport-as-a-service providers who will own and operate fleets of autonomous electric vehicles, providing passengers with higher levels of service, faster rides, and vastly increased safety at a cost up to 10 times cheaper than today's individually owned vehicles."

— James Arbib and Tony Seba, cofounders of the technology think tank RethinkX, in "Rethinking Transportation 2020–2030," May 2017 ✕

"You can count on one hand the number of years it will take before ordinary people can experience [driverless cars]."

— Sergey Brin, Google cofounder, September 2012

_ a pig in a cage on antibiotics.

How would Level 5 cars change our lives?

_ No one can predict

the full implication of driverless cars, but that doesn't mean we won't try. _ Eric Tingwall

The steering wheel is simply collateral damage in the driverless car's crusade. To maximize the big business of automation, the companies behind it will need to own the streets.

We use the word "own" both figuratively and literally, because in an age of debt-laden cities and crumbling infrastructure, there exists a real possibility that cash-rich tech companies could eventually dole out the investments that pave the way for their products. It's just one of the endless possibilities in a driverless future that would repurpose our streets, alter our cities, and change how we live.

Exactly what that world might look like is anybody's guess. The computer-driven car could make America's most congested roads flow freely for the first time in decades, or it could stress

our infrastructure to collapse. It might replace existing transit options in our largest cities while simultaneously killing off the regional transit that largely serves the least mobile populations. It could put millions of Americans out of work or spark the kind of economic boom we haven't seen in decades. The uncertainty stems not from the technology itself, but from the many ways it could be implemented.

"The future won't be determined by what the technology does for us or by pure economics," says transportation historian Peter Norton. "These things are always competitions between groups that have a stake in this future. They're trying to get the future they want."

It's hard to imagine the tech companies not getting what they want, considering the sway a \$90.3 billion corporation such as Google's parent company, Alphabet Inc., holds in American politics. In 2016, the company strengthened that clout by pouring \$15.4 million into its lobbying efforts, landing 11th on the list of top spenders.

It also holds all the cards to insert computer-controlled cars into our lives with ruthless efficiency. After all, it has a file on all of us. "Google has a far better idea of where people are and where they want to go than any government entity," says Anthony Townsend, urbanization expert and author of *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia*.

In 2014, Townsend authored "Re-Programming Mobility," a report that dreamed up four possible futures set in major U.S.

metropolitan areas based on emerging trends such as computer-driven vehicles, cheap solar energy, and the growth of telecommuting. The outcomes range from bleak to hopeful, with the most relatable scenarios built around evolutions of current habits and trends, rather than transformative change. In one of Townsend's possibilities, robocars of differing autonomy levels and from multiple manufacturers struggle to understand one another's behaviors and magnify current congestion woes. (At least Angelenos could go back to sleep once they start their commutes at 4:00 a.m.)

The economic, geographic, and social changes explored here wouldn't materialize overnight. To witness the full effect, you'd need to scan a 15-to-20-year window starting when full automation is broadly commercialized. The car rewired American society twice before in similar time spans—in the early 20th century during the automobile's rise and beginning in the mid-'50s when Eisenhower's interstate system opened the suburbs. Here, we imagine some of the possibilities of how the car's third major act could change our lives:

_ Magic 8 Ball Says . . .

Predicting the future is a fool's game we're happy to play. Presented here are just a few of the ways robocars could alter American society. The more efficient and less expensive driverless travel becomes, the more sweeping the implications for our way of life.

_ Zero or More Persons per Vehicle

Robocars won't transform traffic patterns as long as they have to interact with human-driven vehicles, an inevitability even if they are confined to geo-fenced habitats. When the early versions secure access to carpool lanes, they'll plant the seed for those lanes to eventually be converted to dedicated lanes for computer-driven vehicles.

_ Yeah, Because the French Really Have It Figured Out

Taking a cue from European movements to ban internal-combustion vehicles or all privately owned cars from certain city centers, urban planners might redesign core neighborhoods around limited vehicle traffic, giving a preference to shared, driverless mobility services.

_ High Energy

Driverless cars promise greater energy efficiency as powertrains are electrified and control systems accelerate and brake with computer-optimized precision. However, those efficiency gains are likely to be wiped out by increased travel. Economists know this phenomenon as the Khazzoom-Brookes postulate, which theorizes that an improvement in energy efficiency ultimately leads to an increase in total energy consumption. Applied to cars, it stands to reason that as the cost, in both time and money, of using energy declines, our use for trips both short and long will increase.

_ Empty Cars Everywhere

A driverless fleet built around the demands of the corporate world's nine-to-five schedule would have hordes of robocars idly circling our streets or, more likely, retreating to storage yards at the edges of our cities during off-peak hours. While most experts predict car utilization will go up with the advent of full computer control, the persistence of private ownership could unravel that notion. A 2015 report from consulting firm KPMG imagines that the average occupancy rate could drop below one passenger per trip, meaning cars are more often empty than not.

Public Roads Go Private

Constrained by funding shortfalls and an aversion to new taxes, cities and states may rejuvenate their roads for robocars by turning to private-public partnerships. That could simply mean more toll roads, or it could mean tech companies taking an active role in net-working connected traffic signals and managing the markings and signage critical for Level 5 operation.

Bigger Spare Tires

Door-to-door driverless Ubers would undermine America's preferred form of exercise, walking the parking lots of big-box stores and fast-food joints. If they are as cheap and abundant as promised, robocars are also likely to reduce cycling and walking in urban areas and lull suburbanites into more time sitting in a car when they're not sitting at a desk or on a couch.

The Driverless Car Is Not Alone

The fantasy that computer-driven cars will swiftly supplant all other forms of transportation is fiction. From bike-sharing to steering-wheel-less pods to a 30-year-old Ford Econoline driven by a chain-smoking guy named Slim, our transportation options are likely to become more diverse, not less.

Hypersprawl

Driverless cars are likely to expand our tolerance for commuting as we trade driving for the productive work of trying out new Snapchat filters and sharing our political views on Facebook. Cheap, rural land helps fuel the rise of the exurbs.

Never Search for Parking Again

In 2010, Los Angeles County's 18.6 million parking spots covered roughly 200 square miles, and yet you were still more likely to find Sasquatch riding a unicorn than an empty spot in Hollywood. Urban planners get giddy at the thought of reclaiming lots and structures for new commercial and residential development if private car ownership dwindles.

Look, Another Starbucks!

Today, tech companies deliver ads to their users. In the future, when a computer-driven car chooses the route and exact drop-off location, tech companies can deliver users to their advertisers.

Jaywalking's Big Comeback

Why would a pedestrian ever yield to a car that always yields to people? That was a contentious issue in the early 1900s, too. Newspapers and government officials tapped into the human psyche with a public-shaming campaign that minted the term "jaywalker" (a "jay" was a rube). Our historian, Norton, imagines that driverless cars could shame jaywalkers out of the way by using a distinct audible alert to call attention to any pedestrian obstructing its travel.

Will Drive for Food

The roughly 4 million Americans who work as drivers currently have less job security than a print-magazine journalist. (Though possibly more than any automotive journalist has.)

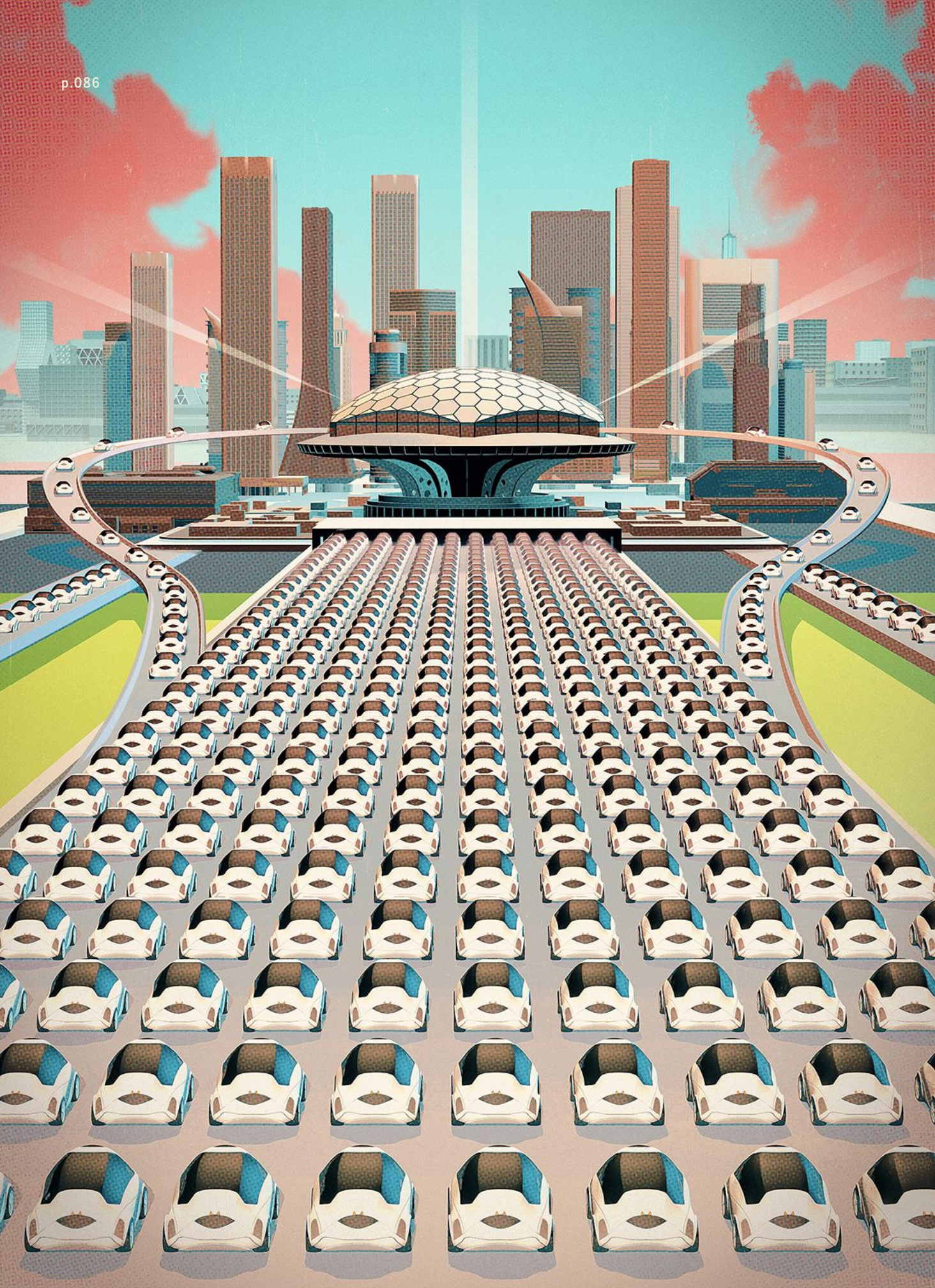
Grounded

Regional air travel could collapse as driverless cars reprogram the time/cost optimization of travel with more speed and greater productivity options.

Ride the Short Bus

In the quest to make all transportation more space efficient, today's 40-foot buses could be traded for smaller 10-to-20-passenger automated shuttles. ✕





pragmatism not idealism.

Who stands to win

and who stands

to lose when the robots

colonize our roads?

Look to the usual suspects.

Pete Bigelow

What's the autonomy economy?

Long before mobility became an auto-industry buzzword, before partiers could summon a ride via an app on something called an iPhone, and before Silicon Valley and Detroit became alleged rivals, William Clay Ford Jr. could foresee the tectonic forces pushing to upend traditional transportation.

As early as the turn of this century, he prodded Ford Motor Company to reckon with a future that would demand more energy efficiency and pollution reduction from its vehicles while also understanding that future populations would be more concentrated in megacities that couldn't absorb additional traffic. In 2007, with a mind toward creating business models that matched such a future, he proposed that the company explore alternate modes of transit. "I'm not sure the term 'mobility' existed, but I wanted to invest in transportation solutions that were different," Ford says.

A few years before that, the Defense Advanced Research Projects Agency lured a band of engineering geeks to the Mojave Desert for a competition, offering a seven-figure prize to the team that ran a driverless vehicle through its grueling off-road course the fastest. No car made it farther than 7.4 miles into the 142-mile course of the first DARPA Grand Challenge. Five robocars completed the race the following year, and in the rapid progress of subsequent Challenges, Google saw enough promise in the technology to launch its own automated-car project in 2009.

Those decisions have proved prescient. Venture capitalists poured more than \$1 billion into automotive-related tech companies in 2016, and they've already surpassed \$2.6 billion in such investments throughout the first eight months of this year, according to CB Insights, a market analytics firm. Silicon Valley tech giants, startups, and traditional automakers alike are rushing to address potential new markets as a result.

It's easy to see why. The worldwide auto industry took in \$2.3 trillion in revenue in 2016, but revenues associated with mobility services—a term the covers everything from Uber to traditional taxis and buses—totaled \$5.4 trillion.

Automated-vehicle technology is already reaching the market in the form of slow-moving shuttle buses and advanced driver-assist features. But as we've seen in this package, fully automated cars, the kind that can take riders anywhere they want to go under any condition, are still at least a decade away from widespread deployment. While no one can say for sure how they'll get to market or what their ultimate use cases will be, it's easy to imagine a world in which robocars will enable passengers to turn their attention toward work or enter-

tainment and let manufacturers unleash new mobility services.

A 2017 report from global consulting firm Strategy Analytics predicts that, once they mature and achieve widespread use in 2035, Level 5 vehicles will be an economic powerhouse that will ripple through both the business and consumer sectors and should generate as much as \$7 trillion in revenue by 2050. The scope of these changes, wrought by what the report's author calls "the Passenger Economy," cannot be overstated.

In 1950, approximately 30 percent of the world's population lived in urban areas. Fast-forward a century, and two-thirds of the world's population is expected to reside in urban areas. This boom will outstrip the capacity of public transportation options and tax existing road and parking infrastructure, leading more people to use mobility-as-a-service options, which will account for \$3.7 trillion of those revenues, according to the report.

Businesses will use these services to reshape their fundamental operations, which will account for \$3 trillion in revenue. "We're going to be moving packages autonomously before we're moving people autonomously," says Kevin Vasconi, executive vice president and chief information officer at Domino's Pizza.

“On the extreme end, we could see the evolution of RVs into autonomous houses that trundle along and nomadic communities that follow work patterns. These are twinkles in people’s eyes, and it’s hard to take full account of that in 2017.”

**Doug Davis, senior
VP of Intel’s Automated
Driving Group**



More employees will work in their cars as driverless mobility frees up more than 250 million collective hours spent in vehicles each year, according to Strategy Analytics. An entire new economy will rise around the 5G-connected services that will drive this mobile workplace. A recent Qualcomm study estimates 5G could spur as much as \$12.3 trillion in revenue for the automotive sector in 2035.

Full automation is predicted to lead to safety benefits that provide economic and societal benefits. In 2010, NHTSA estimated that car crashes cost the United States \$871 billion in losses, equal to roughly 5 percent of the country’s gross domestic product at that time. Meanwhile, as many as 30 million Americans who previously couldn’t drive due to age or disability will exert newfound independence and influence on the economy.

For all the hyped changes, though, some things may remain remarkably consistent. As much as they’ll continue to morph into service providers, automakers are likely to sell more vehicles, not fewer. Silicon Valley companies such as Waymo, the commercial-minded descendant of Google’s automated-vehicle project, have eschewed development of their own computer-controlled vehicles in favor of partnerships with established manufacturers.

Existing ride-hailing services such as Uber might be a big boon for traditional automakers, too. Cars used in such services will reach the end of their life cycles faster than personal vehicles, presenting more frequent sales opportunities for OEMs.

It’s worth remembering that, although you wouldn’t know it from many of their stock prices, traditional automakers remain in strong positions with an entrenched business model that shows little sign of a mobility revolution afoot. Three-quarters of Americans drive alone to work, according to the U.S. Census Bureau, and the rate of carpooling has declined during each decade since 1980. The number of new-vehicle sales in the States reached an all-time high in 2016 with 17.6 million units, per Autodata. And the number of vehicle miles Americans travel annually has increased for five consecutive years; 2016’s 3.2-trillion-mile estimate marked a new record, according to the Federal Highway Administration.

“People are going to tenaciously cling to their ability to own and drive their own cars, and I think that won’t go away for a very long time,” says Roger Lancot, author of the Strategy Analytics report.

What may change as automation evolves over the next couple of decades are the types of vehicles and interior environments that automakers will offer. “We’ll see a whole new rash of vehicle types adapted to local circumstances,” says Doug Davis, senior vice president of Intel’s Automated Driving Group. “On the extreme end, we could see the evolution of RVs into autonomous houses that trundle along and nomadic communities that follow work patterns. These are twinkles in people’s eyes, and it’s hard to take full account of that in 2017.”

For all the predictions, though, there is one underlying fragility. As noted elsewhere in this package, automated vehicles still face a myriad of liability hurdles, regulatory obstacles, to-be-determined safety benchmarks, and other complications presented by the technology itself. Any delay in their rollout could have dire ramifications for ride-hailing companies such as Lyft and Uber, whose business models are dependent on their arrival.

Human drivers account for 45 percent of ride-hailing services’ operating costs, according to management consulting firm McKinsey & Company. As these companies burn through money—Uber lost \$2.8 billion in 2016, according to Bloomberg—driverless technology represents a path toward financial solvency. Yet Uber’s driverless program has floundered amid a lawsuit with Waymo over alleged stolen trade secrets. And Lyft’s cofounder and president John Zimmer acknowledged in July that human drivers “will always” play some role in the company’s operations.

“If Lyft is depending on driverless taxis in the near term to sustain profitability, I’d be worried if I were them,” says Eric Paul Dennis, a transportation systems analyst at the Center for Automotive Research.

For a ride-hailing company such as Uber, any slowdown in the march toward automation may represent an existential threat. For traditional automakers, on the other hand, automation represents an evolving pivot, and they’re well positioned to wait for their bets to mature while enjoying a healthy status quo. ✕



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Whither car culture?

_ When we trade analog for digital, we sacrifice the obsession, addiction, and identity that create values.

_ by Malcolm Gladwell

Starting in the mid-'50s, a European radio station broadcast a rock-and-roll show on Saturday and Sunday nights. Radio Luxembourg, as it was called, played the revolutionary new music from America—songs from artists that the stuffy national broadcasters of the U.K. and Europe wouldn't touch: Bo Diddley, Little Richard, Chuck Berry. A gawky teenager named Keith Richards in the market town of Dartford, east of London, heard Elvis Presley's "Heartbreak Hotel" for the first time on Radio Luxembourg, and it blew his mind. "Radio Luxembourg was notoriously difficult to keep on station," Richards writes in his autobiography. "I had a little aerial and walked round the room, holding the radio up to my ear and twisting the aerial. Trying to keep it down because I'd wake Mum and Dad up." About 250 miles to the north, a 14-year-old named Paul McCartney listened to Radio Luxembourg in bed, through headphones connected by an extension cord to the family radio in the living room. He trained himself to sing just like the voices he heard. A few blocks away, John Lennon would go into a reverie as the Radio Luxembourg broadcast approached, the way a monk would prepare for the catechism. "In the dark front bedroom of his aunt's house on Menlove Avenue, Lennon invariably sat cross-legged on the end of his bed... cradling a full arsenal of notetaking paraphernalia," Bob Spitz writes in his history of the Beatles. "Skillfully, with caressing fingertips, he massaged the dial of his radio... Sometimes he would furiously jot down lyrics to the songs, filling in his own approximation where he'd missed crucial words."

Rock-and-roll led one of the great cultural revolutions of the 20th century, and

that revolution began in teenagers' bedrooms around the world as obsession. The new music didn't come to you. You had to find it: You had to rig up your radio, twist the aerial just so, and set aside your Saturday and Sunday nights. You listened over and over again and wrote down the lyrics. If you could find the money, you went out and bought the single—and later the album, which was a cherished object, carefully handled and passed around proudly to your friends. Richards had a notebook as a 15-year-old, where he listed all his favorite songs in longhand. "The first record I bought was Little Richard's 'Long Tall

Sally,'" Richards writes. Half a century later, he still remembered that fact. The new music, for the generation that discovered it, provided an identity. The Beatles were Teddy boys, whose "mongrel [clothing] style was adapted from a fusion of postwar London homosexuals, who wore velvet half collars on Edwardian jackets, with the biker gangs as depicted by Marlon Brando in the film *The Wild One*," Spitz explains. "A bootstring tie was added for effect, along with skintight jeans... spongy crepe-soled shoes known as 'brothel creepers,' muttonchop sideburns, and long hair greased liberally and combed forward to a point that bisected the middle of the forehead." At the art school where Richards ended up, there was a sharp line between the "beats," who, he says, were "addicted to the English version of Dixieland jazz," and those like himself, enamored of rhythm and blues. His use of the word "addicted" is not an accident. These questions mattered: Richards says he crossed the line once, for a knockout named Linda Poitier. But only once.

Do teenagers still feel this way about music? This is not a trivial question. Popular music was one of the first cultural domains to move from analog to digital, and what happened as a result offers an important lesson to all those facing the same transformation. Some of the news is good: Music today is more popular than ever. Teenagers listen to more songs, of greater variety, and have many more opportunities to hear live performances than their counterparts did half a century ago.

But the language of obsession and addiction and identity that marked its analog beginnings has all but disappeared. You don't have to discover rock-and-roll anymore. There is no cultural equivalent to the Radio Luxembourg broadcast, a thrilling late-night encounter. Streaming services deliver anything you want, whenever you want it. The kid who loves rap dresses much the same way as the kid who loves Kenny Chesney. Will today's 14-year-old girl remember, 50 years later, the first record she bought? No, because she didn't buy a record. She didn't commit to a song. She signed up for a service. For the first waves of teenagers in the rock-and-roll era, the most important question on a first date



“The cultural habits produced of the digital age may have little of the emotional intensity of their predecessors.”

was: What kind of music do you listen to? That piece of information was deemed to be crucial; it allowed you to locate the stranger in front of you on the adolescent socio-cultural grid. (I started listening to Brian Eno—and have never stopped listening to Brian Eno—purely so I could answer “Brian Eno” to the inevitable first-date question of a very beautiful girl named Marina who listened to Brian Eno.) Teenagers today still ask questions on first dates in order to make socio-cultural determinations. Just not that question. Because how can you answer it

if you listen to everything? Popular music has become more ubiquitous and less consequential. It has turned into just another cultural commodity.

In the previous stories in this section, you’ve read an analysis of what the coming automobile age looks like. How soon will full automation arrive? Can we keep technologically dependent automobiles secure from hackers? How does an accident work, legally, when the driver is merely a passenger? But it is equally important to

consider what this new age means. Obsession, addiction, and identity were the building blocks of the analog automobile as well. For a century, the world’s love affair with cars has been sustained by a core of fanatics: tinkerers, gearheads, the automotive parallels of the young Lennon and Richards. Worlds that require effort and interaction build strong bonds of emotional engagement. My father was a college professor in a small town in Ontario in the 1970s and 1980s who insisted on buying high-mileage, second-hand Peugeots, even as one after another, in the face of Canadian winters, rusted down to the frame. Why did he do it? Because to drive a European car, even a lousy one, was a powerful, unstated part of who he was—along with the fact that he read the Bible every morning, took long walks with his dog, and wore a tie when he gardened. (That man produced a son who spends an entirely unhealthy amount of time on Autotrader.) But what does the experience of music teach us? That the cultural habits produced of the digital age may have little of the emotional intensity of their predecessors.

I mean, just take a look at the top 10 musical touring acts of 2016:

1. Bruce Springsteen & the E Street Band
2. Beyoncé
3. Coldplay
4. Guns N’ Roses
5. Adele
6. Justin Bieber
7. Paul McCartney
8. Garth Brooks
9. The Rolling Stones
10. Celine Dion

Of them, only three—Beyoncé, Adele, and Justin Bieber—can be said to be truly of the musical moment. Coldplay and Celine Dion are one generation past their musical prime. And the rest of the artists are all, firmly, historical relics. The economic engine of the music business is running on the fumes of middle-aged men, some of whom did their best work during the Nixon administration. Why? Because apparently almost nothing produced in the modern era can match the enduring emotional power of that earlier work. If I were a music executive, that list would terrify me. And by the way, if I were an automobile executive, contemplating a digitized future, I’d be just as frightened. ■

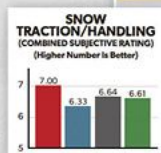
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'17 Mazda CX-5 FWD
225/70R16 Pirelli Scorpion Winter
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It's a Hellcat Thing



YOU MIGHT NOT UNDERSTAND
THIS 707-HP JEEP, BUT ONE JAB AT
THE THROTTLE WILL TELL YOU ALL
YOU NEED TO KNOW. LOUDLY.

_by JARED GALL _photography BY GREG PAJO



▲
2018 JEEP GRAND CHEROKEE TRACKHAWK

“W

e are still dealing with physics here. I just want you to remember that.” So says Erich Heuschele, manager of SRT vehicle dynamics, to the 20 or so writers he’s about to turn loose on a racetrack in the Jeep Grand Cherokee Trackhawk. We’re dealing with physics, sure, but also an earnest effort to defy them with equal parts horsepower and lunacy. Say “707-horsepower Jeep” to anyone who hasn’t been paying attention and they just wiggle a finger into an ear and squint at you. “Huh?”

That same phrase, the one with the big number lashed to that old army word, carries the mystical power to convince even the most jaded auto writers to back away from the lobster roll and don a balaclava. We did drive the maximum Jeep on public roads, but it says “track” right there in the name, so we also hit Club Motorsports, a New Hampshire club track so new that crews were still installing Armco barriers the week before we showed up. It’s a 2.5-mile StairMaster that works its way up and down 250 feet of elevation change at a maximum 14 percent grade. Keeping his new Trackhawks from bending that fresh Armco is something about which Heuschele cares deeply.

The topography, on the other hand—nobody’s too worried about that. Few things flatten the hills quite like this much horsepower.

Insane as it may be, the 707-hp Hellcat engine should at least be familiar by now. Down 251 cubic centimeters compared with Mopar’s naturally aspirated SRT engine, it’s a 6.2-liter V-8 capped with a 2.4-liter IHI supercharger, which stuffs those eight cylinders with 11.6 psi of boost. In the Trackhawk, it makes its full complement of horsepower but loses five pound-feet of torque—to 645—due to a more restrictive exhaust system.

Caught up in a sledgehammer fight against the V-8, engineers applied the same blunt-force mentality to the rest of the powertrain: There’s a beefier transmission and a stouter transfer case, plus a reinforced rear driveshaft, half-shafts, CV joints, and differential. The front axle is the same as the regular SRT Jeep’s. That transmission is still a ZF eight-speed, now christened 8HP95 and officially rated to handle up to 811 pound-feet of torque. The transfer case routes torque forward with a wider chain than in the naturally aspirated SRT, with forged-steel sprockets instead of powdered-metal ones. Tube-wall thickness is up on the rear drive-shaft, and the differential housing gains a mount, going from three to four. Inside, the diff itself goes from two spider gears to four, with a modified tooth geometry for greater strength. The Hellcat engine alone outweighs its naturally aspirated brother by 108 pounds, and everything aft of it adds another 105, according to Jeep. But that’s for identically equipped vehicles. At 5258 pounds, this Trackhawk actually weighs less than the last Grand Cherokee SRT we tested



(at 5291 pounds), which was equipped with a panoramic sunroof.

Like the Challenger Demon, the Trackhawk gets the so-called Torque Reserve function to aid launching. With launch control engaged and the Jeep brake-torqued, this system cuts fuel to individual cylinders, allowing the engine to rev higher and the supercharger to build more boost—6.4 psi as it sits at the line. Lift your foot off the brake and the Trackhawk will squawk all four 295/45ZR-20 Pirellis on its way to a 3.5-second zero-to-60-mph time. We couldn't match Jeep's 11.6-second-at-116-mph claim for the quarter-mile; our best run took 12.0 seconds at 115 mph. But the Trackhawk's acceleration made Club Motorsports' 14 percent grade feel as flat as it looks in Google Maps' 2D view—where, incidentally, the track still shows up as a dirt lot as of this writing. We told you it was new. Our one complaint about the engine is that we want more blower whine when we mat the accelerator. There's a good bit under lighter loads, but at full throttle, it fades behind a raging gargle blaster of an exhaust roar so fierce it sounds as if the tailpipes are emptying into the cabin. *The call is coming from inside the house!*



Will the Trackhawk visit tracks more or less often than the Trailhawk traverses trails? Likely, it'll mostly be used around town to wake the dead.

Barging back down Club Motorsports' hills demonstrates the rest of the Trackhawk's skill set. It retains the SRT's control-arm front and multilink rear suspension layout, but the springs are 9 percent stiffer up front and 15 percent stiffer out back. Not surprising for something so heavy and with so much rubber at each corner, it's quite stable—a desirable trait on a course with lots of camber variances. But toe the brake and it'll rotate. Lay into the brake and it'll dance disconcertingly, even in a straight line. The steering is a touch slow but heavy enough for perceptible weight to bleed off as the nose starts to wash out. We half expected to find a fresh furrow plowed around our skidpad after the Trackhawk turned 0.89 g, and 2.6-ton vehicles don't typically stop from 70 mph in just 168 feet without at least one major impact. That figure could be even shorter if the Trackhawk weren't shy on clamping force. ABS never engaged no matter how hard we stomped the pedal. Describing his braking tests, assistant tech editor David Beard pantomimed sliding under his lap belt with both feet reach-



2018 JEEP GRAND CHEROKEE TRACKHAWK

VEHICLE TYPE: front-engine, all-wheel-drive, 5-passenger, 4-door hatchback

PRICE AS TESTED: \$90,880

BASE PRICE: \$86,995

ENGINE TYPE: supercharged and intercooled pushrod 16-valve V-8, iron block and aluminum heads, port fuel injection

DISPLACEMENT: 376 cu in, 6166 cc

POWER: 707 hp @ 6000 rpm

TORQUE: 645 lb-ft @ 4800 rpm

TRANSMISSION: 8-speed automatic with manual shifting mode

DIMENSIONS

WHEELBASE: 114.7 in

LENGTH: 189.8 in

WIDTH: 76.5 in

HEIGHT: 67.9 in

PASSENGER VOLUME: 106 cu ft

CARGO VOLUME: 36 cu ft

CURB WEIGHT: 5258 lb

ing toward the bottom of the footwell.

At 15.7 inches, the Trackhawk's aluminum-hat front rotors grow 0.8 inch over those on the naturally aspirated SRT Grand Cherokee. The rears, at 13.8 inches, remain the same. Six-piston front and four-piston rear calipers are employed on both sport-utes, but the Trackhawk's get a coat of yellow paint. Jeep hopes you like it, because it's what you get regardless of exterior color or wheel choice.

Those yellow calipers are one of the Trackhawk's few exterior tells. Others include the deleted fog lights, their nests hollowed out for an oil cooler where the right one used to live, and a cold-air intake at the former address of the left one. A new rear fascia accommodates the quad exhaust outlets. There's a subtle "Trackhawk" badge on the lower-right corner of the liftgate and "supercharged" script below the Grand Cherokee lettering on the front doors. There are Trackhawk logos on the sillplates and the seats, a 200-mph speedometer—optimistic by only 20 ticks—and an available model-exclusive red-and-black interior.

The rest of the cabin is standard SRT Grand Cherokee fare: spacious, with comfortable seating front and rear and a sizable cargo hold. There's a reason the Grand Cherokee is one of the best-selling SUVs in the country, and those 200,000 or so annual buyers aren't making bad decisions. At least in this case. While the Trackhawk's stiffer ride is noticeable on New England's bumpy country two-lanes, it's not so harsh as to be a turn-off.

But the Trackhawk offsets its 707-hp mating call with an unavoidable wart: its \$86,995 base price. That's \$17,905 more than what you'll pay to get a Hellcat in a Charger and \$20,405 more than it costs in a Challenger. The Trackhawk is nearly as quick as both of those, and it's far more livable. Plus it'll tow 7200 pounds, enough to let you bring the Hellcat of your choice along on a trailer—even if it's a spare Trackhawk. The hang-up comes when

[+] The world champion of indiscriminate throttle application.

[-] Above \$80K, the "why not get a ___?" question becomes harder to answer.

you start adding options and look at similarly priced performance SUVs. It's not hard to top \$100,000 with a Trackhawk. No, the BMW X5 M and the Mercedes-AMG GLE63 don't have horsepower ratings starting with lucky number seven, but they're in the same performance ballpark and offer more polish and greater—if wholly different—prestige. Unless, of course, a buyer just wants the Hellcat mania in a manageable package. At a price point and power level where reason has often left the building, that's something we actually can understand. ■

G/D TEST RESULTS

ZERO TO 60 MPH: 3.5 sec

ZERO TO 100 MPH: 8.8 sec

ZERO TO 150 MPH: 24.4 sec

ROLLING START,

5-60 MPH: 3.8 sec

1/4-MILE: 12.0 sec

@ 115 mph

TOP SPEED: 180 mph (drag limited, mfr's claim)

BRAKING, 70-0 MPH: 168 ft

ROADHOLDING,

300-FT-DIA

SKIDPAD: 0.89 g

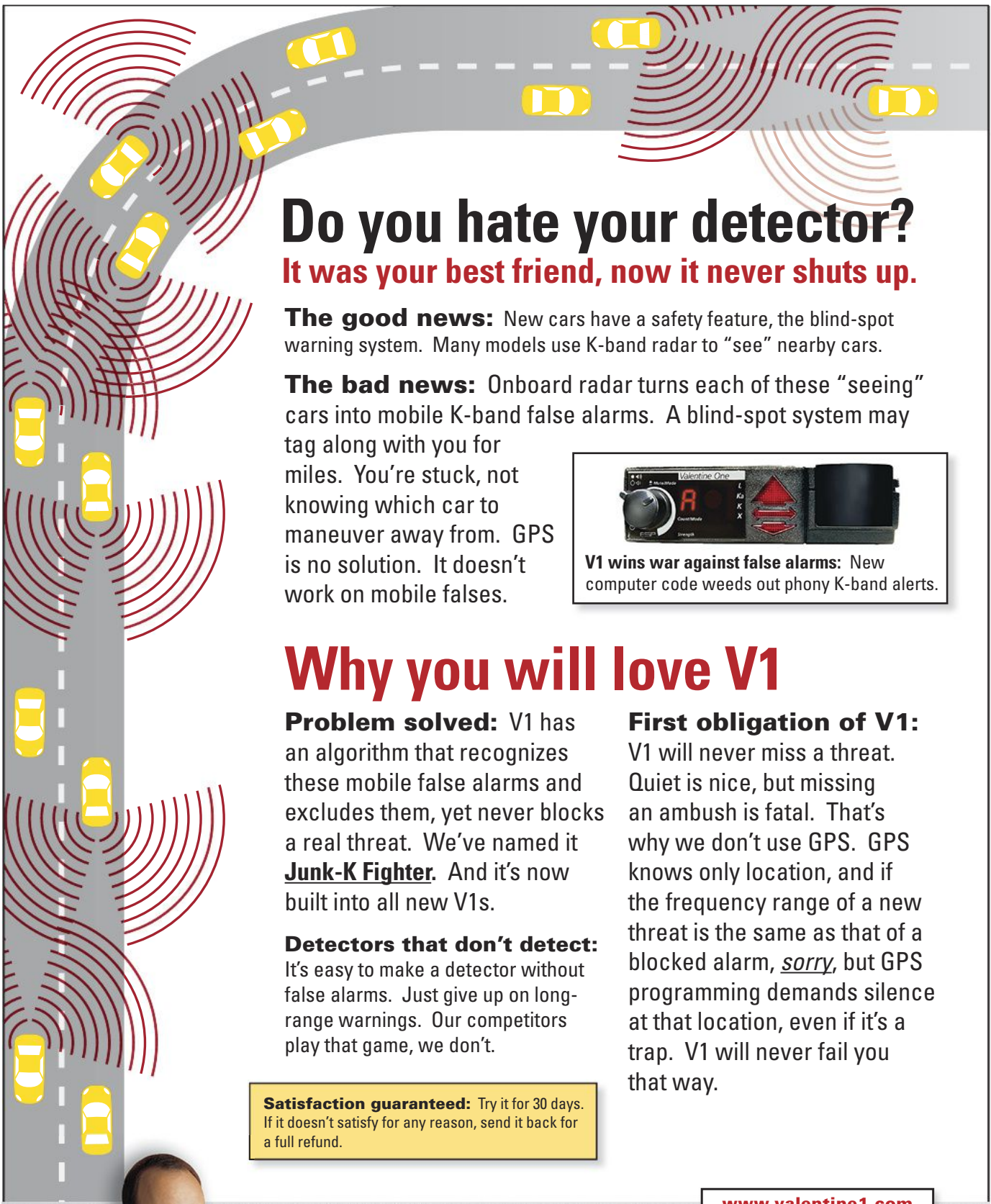
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MICHIGAN
MUD JAM.

BY MIKE DUFF
PHOTOGRAPHY BY ROY RITCHIE





It takes less than five minutes after driving through the gates of the Iosco County Fairgrounds in C/D's long-term Ford F-150 Raptor to realize that I am altogether too sober for the Michigan Mud Jam. Now in its fifth year, the Jam transforms the normally peaceful town of Hale into what's claimed to be the "largest bog in the North." This, it seems, is a thing to be quantified and compared. Around 15,000 people have shown up for what amounts to a celebration of torque's ability to conquer gelatinous quagmire, but also—judging from the Confederate flags—a celebration of rebellion. The obvious question of "why?" is one that has been turned, by the vast crowds and their near-universal inebriation, into "why the hell not?"

Many seem to be here just for the chaotic campgrounds, which have a postapocalyptic feel reminiscent of the *Mad Max* franchise. ATVs and trucks, a few even more immaculate than the Raptor—despite having been here since Wednesday—are driving loops through the mud, weighed down with human cargo. Many of the ATVs are hauling trailers for more passengers, with a goodly percentage of them modified with party lights and sometimes even the upright poles that characterize the sort of club that specializes in exotic entertainment. The crowd is mostly young, guys and girls in their 20s, many barely dressed apart from thick scarves of Mardi Gras beads.

Coming from the U.K. where spring means having to wear only one sweater, I've never attended a Mardi Gras or spring break, so I'm a virgin in such matters. Initiation comes quickly, though. As the Raptor sits in traffic, a woman saunters over and holds out a string of purple plastic beads.

"Beads for boobs!" she says, her voice slurring slightly as beery breath fills the cabin.

"Um, you want to see my boobs?"

"No, you give them to girls, and then the girls show you their titties." Her tone expresses incredulity that someone so ignorant could have ended up with such a nice truck. "Like this!"

She drops the beads in my lap and hauls up her top to reveal an impressive, if mud-streaked, chest. Her half of the bargain done, I hand her back the beads and she puts the string around her neck with many others. Seems like a good deal. The watching crowd cheers.

WITH THE RAPTOR PARKED, I can start working on eradicating both my unfortunate sobriety and my British reserve. By coincidence, the previous motorsports event I attended was the Goodwood Festival of Speed where, in the Mercedes hospitality tent, I drank chilled rosé and ate cucumber sandwiches with their crusts trimmed.

I ask a guy standing by himself and swaying slightly as he swigs from a can in a foam koozie where I can buy a beer. "You can't. Not in here. You bring them in." He nods to the cooler by his feet. Then, recognizing my lack of beverage, he nudges it open with a muddy boot. "Or you borrow one. Here." He hands me a cold can of Miller Lite. You don't find generosity like that at Goodwood.

But the campgrounds are just an appetizer to the bloody red meat of the mud pit, where unsilenced engines bellow as a peanut gallery whoops and hollers. This is an acres-vast man-made bog, carefully constructed in the middle of a system of levees to ensure

that, however much or little rain has fallen, water can be diverted to give the bidders their desired level of mire. This ranges from knee-deep to what appears to be an actual lake. The place is filled with trucks, some moving, some stationary, and some very clearly stuck. It looks like the Third Battle

Opposite middle: Duff learns the meaning of business up front and party in the back.
Opposite bottom: Keep your teeth mud-free to reduce clean-up time.



of Ypres or one of Hieronymus Bosch's less whimsical takes on the afterlife.

The view from the edge is limited, so *C/D*'s photography team and I talk our way onto a sky-high appliance that is heading toward the entrance. We're waved onboard with a friendliness that becomes the hallmark of the weekend.

This, I'm told, is a platform truck or a swamp buggy, a towering frame atop a heavy-duty chassis with colossal mud-pummeling tires, powered in this case by an often temperamental V-8 mounted several feet below us. After a couple of false starts, the engine fires to life and we head out into the pit. Which, it soon transpires, is a more viscous version of a roiling ocean. Being big and slow, the truck rides the oozing peaks and troughs like a destroyer in a brisk sea, a stately pace compared with the smaller trucks that are attacking it like speedboats, some practically skimming the surface. We roll to a carefully chosen vantage point and stop next to a bigger rig.

"This is nothing," says Ryan Carter, one of our platform truck's owners, who is a toolmaker by trade. "We've had the tires go all the way under in other bogs." The original plan for the truck was sketched on the backside of a flattened beer box a couple of years ago. Carter and six buddies spent several hundred hours building it to bring to events like this. He figures they put in 36-hour weeks on top of their day jobs. Far below us sits a donated truck frame, but I don't catch the details. The bigger, adjacent rig was finished just hours before the event started, and there's an even taller one circulating the pit that seems to be built around the chassis of an old garbage truck.

Innovative engineering is everywhere. The more heavily modified mudders have relocated their radiators to their load beds to better protect them from the sludge. A few trucks still have windshield wipers, although these seem to have little effect on the heavy clay loam beyond spreading it more evenly. Others have plastic screens with narrow cutouts to allow some forward vision, although it must be like rolling into combat wearing the helmet of a medieval knight.



From the top: Swamp buggy viewing platforms are like safari trucks for the exceptionally drunk. Butts, bogs, and boat-trucks. Can I get a hell yeah?

The bog is open for what's pretty much a free-for-all, with trucks and SUVs of every shape and size trying their hardest to find a part of the pit they can't get through. Some are practically bone stock; a shiny F-150 sits beached in one of the shallower areas and makes me glad I heeded my editor's strict instructions not to subject the Raptor to the pit. But most have been lifted, sometimes stratospherically, and sit on huge tires. When trucks get stuck, other trucks come to try and rescue them, and when those get bogged, there's an excavator and a bulldozer to pull them out. "The bulldozer got stuck yesterday," says Carter.

If there are any rules, I'm struggling to divine them. Carter makes the "you idiot" face when I ask him about the etiquette of the pit. "Whatever's bigger or traveling faster has got priority," he says. "Don't get in its way, it ain't stopping. And don't spray other people; that's just good manners."

Our high-riding platform truck, miraculously, keeps us all clean as it braves the swamp, but folks are clearly here to get as dirty as possible, to judge from the number of roofless vehicles in the pit. There are several Frankenstein specials that have spliced unlikely bodywork onto ladder-frame chassis: There's a Mercedes W123 sedan, a Chrysler 300C, a Ford Mustang boasting the legend "Ignorant," and—the clear winner—a BMW 3-series cabriolet. Clear winner apart from the speedboat on wheels, that is.

There are driving skills in evidence, with smaller trucks seeming to pretty much levitate to unlikely places in the bog. But most of the people in the mud pit believe that victory comes not from skill but from superior firepower. A lifted Chevy S-10 makes a spectacular run almost directly toward us, along a course that seems to have been carefully selected to take in the thickest mud and most challenging swamp elements. It earns full marks for style—

engine bellowing and roostertails of filth flying at least 50 feet into the sky. But the speed creates a bow wave of mud that shears off the pickup's grille and then its bumper, this Viking death marked with cheers, rebel yells, and the two-fingered devil-horn salute that always takes me back to rock's worst-haircut era. Clearly inspired, a less well prepared K5 Blazer tries the same thing and judders to a stop with a smoking transmission. Moments later, to even louder acclamation, it catches fire.

Why? Why the hell not?

AS THE AFTERNOON DRAWS ON, the center of the pit slowly clears as trucks leave under their own power or get dragged out. It's time for freestyle, the closest these proceedings get to an actual competition, where the most heavily modified trucks get scored for stunts and jumps over the ramps and berms molded from the mud. There are impressive wheelies and big air, but it's way short of the slick stunts of Monster Jam, with a surfeit of enthusiasm over expertise. There are long pauses as many of the competitors suffer expensive-

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looking crashes, rolling and then needing to be righted by the excavator. Later on, there's a tug-of-war with an equally high rate of mechanical attrition, including a Jeep Wrangler that chews up its massive rear differential as if it were made of cheese. Nobody seems to mind their trucks breaking. Wrecking stuff is part—or maybe most—of the fun.

THE NEXT DAY, dawn breaks loudly over 10,000 hangovers, and the mud pit is full again shortly after breakfast. My first sight of it is an excavator pulling a tow truck that's pulling a Chevrolet with a broken front axle. An ex-military Hummer is out playing, looking as dinky as a child's toy next to the massively lifted machinery that surrounds it. T-shirt slogans are sometimes witty but overwhelmingly obscene, ranging from "Ditches Eat Bitches" and "Your Hole, My Goal" to a hundred variations on the "your mama" joke and questions about the reader's parentage. In the campgrounds, music plays from vehicles and PA systems—an eclectic mix of country, rock, and rap, all of it loud and much of it terrible. A couple of the immaculately dressed state troopers who constitute the law hereabouts deign not to notice a heavily amplified blast of "Fuck tha Police" as they roll past on gleaming ATVs. Their olfactory receptors seem to be similarly immune to the pungent aroma of marijuana, doubtless medicinal, that hangs over the site.

But by late morning, the Jam is redolent with more than the fragrance of sweet Mary Jane. A blazing sun is reddening necks to an appropriate degree, and heat is rising to the mid-80s. The Porta-John toilets are starting to reek—the campsite has been open for three days already—and the thickening mud is smelling pretty bad as well. To escape the choking miasma, we head farther into the camping areas, back to where the ATVs are still circulating and many spectators have set out signs saying, "Big or small, let's see them all." I ask a guy holding scorecards what his highest rating has been. "Coupla nines, mostly fives or sixes, and plenty of ones and twos. Sometimes they're hauling their tops up, and sometimes they're hauling them down, if you get what I mean." This man is clearly a connoisseur.

Wandering deeper, we find the 3-series cabriolet that impressed us yesterday being strapped onto a trailer. Owner Paul Sivyer is getting ready to head home. "It did better than we thought it would do. We launched it and blew the transmission when it landed." Under-



neath, it's a Chevy Blazer, Sivyer having chosen the E36 cabrio after discovering the two wheelbases were surprisingly similar.

The almost-BMW is parked next to one of the huge freestyle trucks, a one-time Chevrolet Colorado that now sits on a fabricated chassis tall enough to put its door handles above head height. I saw it yesterday in the pit and was drawn to its name as much as anything else: White Trash. It belongs to Chris and Julie Lendvoy, who have spent hundreds of hours and tens of thousands of dollars creating it. "If you wanted to replicate it, then you'd be looking at probably \$50,000," Chris says, before trying to give me a technical rundown. It's got a 632-cubic-inch Chevy V-8 and what he describes as a "plant axle," but the details of the suspension might as well be delivered in French Creole for all the sense I can make of them. "I wrecked it last year," he says. "We finished it on Tuesday and came straight here. I'd like to do more competitions, but it's all about getting the seat time. I built it to jump big, real big."

By Saturday afternoon, many other broken trucks are being loaded onto trailers for the journey home, others wait for salvation in the pit. Things are winding down, but not for everyone. I return to the Raptor to find three young guys sitting in the bed of a beat-up F-150 parked beside it, looking at the bead-wearing women with the bug-eyed expression of the newly arrived. The truck is wearing an Iowa license plate.

"We saw this on Wednesday on the 'Trucks Gone Wild' Facebook page and decided to come straight here," explains one of them. "We finished work and drove 10 hours straight."

Mud Jam does feel like the gathering of a clan, of self-proclaimed rebels drawn to an event with the trappings of motorsports but without the challenge of actual competition. But that might be overthinking it. It's also just a party with trucks, and mud, and the chance to see a few boobs and maybe even rate them. Yet the time and effort that people put into preparing for what's obviously a major highlight of their year is striking, and it's clear that the same "build it, break it, build it better" ethos that guides even the most exclusive race series is alive and well in a man-made swamp in northern Michigan.

With the V-8s, endless mud, and a barter-based economy that sees plastic beads traded for peeps, it's also an indication of what the end of the world will probably look like. It looks like fun. ■

Below left: This Hale Area Football guy is making a killing on returnables. Below: The E36 is the generation of choice for Blazer conversions.



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Velar—Oh!

Land Rover's new **Range Rover Velar** is a suburban delight.
_by Davey G. Johnson



A LITTLE-KNOWN FACT: In 1969, British Leyland engineers were plying the roads and sheep paths of Blighty in something badged “VELAR”—a new type of Land Rover meant for the fox-hunting upper crust. The badge was a simple ruse constructed from parts-bin “LAND ROVER” letters, and not long after, Land Rover’s erstwhile Velar arrived in showrooms as the Range Rover. Today, the Range Rover lineup offers everything from the citified dartabout Evoque to a brand-eponymous long-wheelbase Clydesdale appointed as opulently as anything this side of the St. Regis New York.

The Velar’s name suggests a direct connection to the full-size Range Rover, but its underpinnings come from its corporate cousin, the Jaguar F-Pace. Dimensionally, the five-passenger Velar slots between the 2.1-inch-longer Range Rover Sport and the 8.4-inch-shorter Discovery Sport. And its styling splits the difference between the Evoque and the Range Rover Sport. The new machine

features the smaller ute’s chop-top greenhouse set above a more lithe, elegant version of the Sport’s lower section. Though rich with detail, the Velar’s trendy copper-colored accent trim, available on First Edition and R-Dynamic models, doesn’t feel overwrought or exaggerated. Buyers not fond of such metallic flair can opt for one of the Black packages, which offer a dark monochrome offset to the chosen body color.

Three engines are available, starting with a 247-hp turbocharged 2.0-liter inline-four. A 380-hp supercharged 3.0-liter V-6 and a 180-hp turbo-diesel four-cylinder round out the lineup. All three are mated to an eight-speed automatic transmission with paddle shifters. Pricing starts at \$50,895—just \$90 shy of the V-6-powered 2017 Discovery—and hits the stratosphere with the high-end \$90,295 First Edition model we drove.

The Velar’s substantial mass—which we estimate between 4600 and 4800 pounds, depending on trim—is well controlled under every input other than acceleration. That said, any sense of laggardness is more of a generalized sensation than a demerit, as the V-6 Velar tops out at 155 mph and should make the run to 60 in 5.4 seconds. While Jaguar Land Rover’s supercharged V-8 (not available in the Velar) remains a frivolous, thirsty joy and its new Ingenium four-cylinders are solid performers, the six is aging poorly, feeling coarse, unrefined, and slightly bovine in tone.

Drivelines

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The SUV's suspension uses control arms up front and JLR's multilink rear setup. When fitted with air springs, the Velar rides more like its relaxed larger brother, rather than imitating the city-ute temperament of its smaller sibling. We didn't have a chance to sample the lower-spec coil-spring setup, but the height-adjustable columns of air grant the Velar up to 9.9 inches of ground clearance (steel-spring models offer 8.4 inches) and excellent ride quality. Overall, the driving experience has more in common with the full-size Range Rover than it does the small Evoque, offering up a pinch of regal waft and substance over the road. Steering is light and accurate, and the Velar dodges the sensory-deprivation-chamber trap by lightly telegraphing the road surface through the rim of the wheel. The brakes don't astonish, but they also don't call attention to themselves through any glaring fits of inadequacy. Pedal response is intuitive and confidence-inspiring, doling out a linear application of stopping force.

Interior appointments in the First Edition—trim Velar—save for a cheap-feeling cupholder cover—are up to par and, indeed, feel significantly more luxurious than those of its German and Japanese rivals. Rich leather is a given on uplevel Rangies, and the First Edition's Windsor leather is some of the finest-feeling hide available. More interesting is the wool/synthetic-suede interior, recalling the days when fancy fabrics were just as desirable as cattle skins. Class-intending sybarites need look no further, though they may want to act quickly, as only 500 First Editions will reach the States.

The center stack is an aesthetic wonderment in piano black, featuring two HVAC knobs beneath a long, sweeping touchscreen. Said screen supplements the pinch/swipe/tap-enabled dash display, which looks for all the world like an iPhone 3G subjected to a session on the Spanish Inqui-

sition's rack. Unlike JLR's chronically laggy infotainment systems of old, the new Touch Pro Duo setup works quickly, though touchscreens will never be a substitute for a good knob-and-button system. And while the dash screen's design may reach back to Apple's classic phone of nine years ago for inspiration, the Velar's attitude toward connectivity is strictly modern, offering a 4G LTE Wi-Fi hotspot for up to eight devices.

A victim of the brand's techy, minimalist design, the Velar's Terrain Response driving modes are selected by tapping an illuminated icon on a flat surface rather than turning a knob, which isn't ideal when a driver's eyes should be on the road or trail. But given this SUV's intended demographic, we imagine that the idea of having off-road modes beguiles more than the act of selecting them. The system offers distinct settings for an Eco mode as well as Comfort, Grass/Gravel/Snow, Mud/Ruts, Sand, and, our favorite, Dynamic, which is Land Rover's code for "sport." The optional Terrain Response 2 (standard on the First Edition) adds an Auto

mode to the mix that, depending on surface conditions, shifts its algorithm to find the best combination of torque split, stability control, traction control, throttle response, and gear selection. The Velar is sure-footed and capable on less-than-ideal terrain, scrambling up slick, loose, shale-littered trails with ease, and matter-of-factly tackling an indoor obstacle course designed explicitly to show off its capabilities. At one point, a spotter had us hanging in the air, supported only by the right-front and left-rear wheels. He then commanded us to move our heads toward the base of the A-pillar. That bit of weight transfer was enough to gracefully drop the ute down onto its left-front wheel. "That," he proclaimed, "shows how well balanced this thing is." It also illustrates how skilled Land Rover's team is at building obstacle courses. While you might not deign to retrace old Camel Trophy routes in the Velar, especially on the First Edition's flashy 22-inch rims, it's got more than enough four-wheel moxie to satisfy its intended owners.

With its best-of-brand styling, multiple engine options, and wide-ranging price points, the Velar adds to Range Rover's already potent lineup of luxe utility wagons. It's certain to find favor with BMW, Lexus, and Mercedes customers, which isn't bad for a vehicle that started life as an anagram.

2018 LAND ROVER RANGE ROVER VELAR

VEHICLE TYPE: front-engine, all-wheel-drive, 5-passenger, 4-door hatchback

BASE PRICE: \$50,895–\$65,195

ENGINES: turbocharged and intercooled DOHC 16-valve 2.0-liter diesel inline-4, 180 hp, 317 lb-ft; turbocharged and intercooled DOHC 16-valve 2.0-liter inline-4, 247 hp, 269 lb-ft; supercharged and intercooled DOHC 24-valve 3.0-liter V-6, 380 hp, 332 lb-ft

TRANSMISSION: 8-speed automatic with manual shifting mode

DIMENSIONS
WHEELBASE: 113.1 in
LENGTH: 189.1 in
WIDTH: 76.0 in
HEIGHT: 65.6 in

PASSENGER VOLUME: 99 cu ft

CARGO VOLUME: 34 cu ft

CURB WEIGHT: 4600–4800 lb

PERFORMANCE (C/D EST)

ZERO TO 60 MPH: 5.4–9.2 sec

ZERO TO 100 MPH: 13.9–27.9 sec

1/4-MILE: 14.1–17.2 sec

TOP SPEED: 120–155 mph

FUEL ECONOMY
EPA COMBINED/CITY/HWY: 20–28/18–26/24–30 mpg

[+] Finest styling in the current Range Rover portfolio, most dramatic interior in its class, superb ride on air springs. [–] Supercharged V-6 feels archaic in this application, touchscreen mods kill more knobs.



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TESTED

Sub-Suburban

Chevrolet is at its best in the new, larger-than-your-life **Traverse**.
_by Jeff Sabatini



CHEVROLET MAKES EXACTLY two unassailable products. One is the Corvette and the other is the Suburban. While we might prefer that more new vehicles use the former as a template, we can begrudgingly accept the latter as a North Star for the completely redesigned Traverse. And what a redesign this is, taking last year's outdated minivan surrogate from back-of-the-pack anonymity to best-in-class contention in most every area.

The Traverse's makeover starts with a literal one. Its designers took inspiration from the brand's full-size SUVs, and the three-row crossover resembles a downsized Suburban from its huge wheelbase to its thick C-pillars to its long roofline. It has an unabashedly masculine, truckish look, created to address the soft styling that Chevy's marketers say was the old Traverse's biggest turnoff.

The mini Suburban is a platform-mate of the GMC Acadia, which finished a distant third in our August comparison test of five crossovers. But the Chevy rides on an 8.4-inch-longer wheelbase than the GMC, uses a different powertrain [see tech highlight], and offers a nicer interior. In High Country trim, this Traverse is also more expensive than that Acadia Denali, which was the most expensive vehicle in that test.

[+] Slick powertrain, nice interior, bigger is better.
[-] But is bigger really better? Prepare for sticker shock.

At 204.3 inches in overall length, the Traverse even outmeasures by six inches the Volkswagen Atlas, the big boy that earned our runner-up accolades. With much of that length devoted to its luggage hold, the Traverse boasts 23 cubic feet of storage behind its third row and 58 cubic feet behind the second with the third row stowed. Both rows fold to create a truly flat load floor. Those cargo figures mean the Traverse offers two cubic feet more than the VW in both metrics, giving the Chevy best-in-class cargo capacity.

Now you might think that such a Brobdingnagian crossover would drive like a big, hulking body-on-frame vehicle. But you would be wrong, because Chevy engineers did a masterful job in suspension and steering tuning. The old Traverse didn't feel like the two-and-a-half-ton elephant it was, and the new one drives even better. The electrically assisted power-steering system demands only a light touch but rewards the driver with consistent and appropriate feedback. The new Traverse rides on struts in the front and a multilink suspension in the rear, a combination that delivers a plush ride and absorbs harsh impacts without jostling occupants. Driving dynamics are helped by a 270-pound weight reduction compared with the last generation; our test vehicle weighed 4680 pounds, which is about 50 less than a loaded Atlas.

A revised 3.6-liter V-6 makes 310 horsepower and 266 pound-feet, giving the Traverse one of the better weight-to-power ratios in its class, though a turbo 2.0-liter inline-four with an estimated 255 horses is also available. The V-6 we tested is good for a zero-to-60-mph sprint in 6.5 seconds. A new nine-speed auto is standard with both engines; it delivers almost imperceptible shifts and helps seamlessly integrate stop-start functionality. That helps the Traverse pick up 3 mpg in its EPA combined ratings, which climb to 21 mpg for the front-drive version and 20 for all-wheel-drive trims.

Drivelines

The High Country interior finally answers the question, “What have GM designers been smoking?” It is much improved from previous attempts at executing the layered-materials look that pervades so many GM cockpits, from Chevrolets all the way up to the Cadillacs at the top of Sloan’s ladder. But the restraint with which this sometimes busy style is applied in the Traverse makes it the company’s most fully realized interior. Metallic trim pieces are classy and the leather has a high-quality feel. Less expensive Traverses come with cloth and vinyl upholstery and more plastic trim, but even those commodity-grade materials are nicely deployed.

Seating in all three rows is comfortable, if not cushy. Rear-seat access is excellent, and legroom is plentiful in the back. While the third row is adult-friendly with the second row moved forward, the thick C-pillars significantly limit the view. Chevy figures that those

plugged into their electronics will not even notice, so it aids and abets the screen-time generation with a standard pair of USB ports in each row. Conspicuously absent from this family-oriented hauler is any rear-seat entertainment system, a tacit admission that the days of car manufacturers making big profits on such electronics are over. In the same vein, Chevy’s driver infotainment system evolves in the only way that matters: It supports Android Auto and Apple CarPlay, which are now available for the first time in the Traverse.

The Traverse can be had with seating for seven or eight, with one caveat. The second-row bench seat is only available with cloth upholstery—if you want leather, you’re getting captain’s chairs, which means if you want eight seats, you’re restricted to lower trim levels. All-wheel drive is optional on most trims, but not on the \$30,875 base model; it only comes in front-wheel drive. The least expensive all-wheel-drive model is the LS at \$34,995. And if you want to take advantage of the Traverse’s 5000-pound towing rating, you’ll need to step up to the LT, which starts at \$35,495 for a front-driver, not including \$650 for the trailering package. The LT is also where advanced safety aids become available. Prices escalate sharply from there, with leather-equipped models topping \$42,000. The well-packaged Premier trim starts at \$45,395 for a front-driver or \$48,295 for one with all-wheel drive.

And that brings us to this High Country Chevy Traverse and the inevitable question: How would it have fared against the Volkswagen Atlas and the winning Mazda CX-9 had it been available for our recent comparo? It certainly wouldn’t have finished worse than the GMC, and the Traverse’s strongest suits—interior size and power—neuter the VW’s best attribute while attacking its most obvious weakness. In a testament to how thoroughly good this Traverse is, we’re already mulling a head-to-head with the CX-9.

2018 CHEVROLET TRAVERSE HIGH COUNTRY AWD

VEHICLE TYPE: front-engine, front-/all-wheel-drive, 7-passenger, 4-door hatchback

PRICE AS TESTED:

\$52,995

BASE PRICE: \$52,995

ENGINE TYPE: DOHC 24-valve V-6, aluminum block and heads, direct fuel injection

DISPLACEMENT: 218 cu in, 3564 cc

POWER:

310 hp @ 6800 rpm

TORQUE:

266 lb-ft @ 2800 rpm

TRANSMISSION:

9-speed automatic with manual shifting mode

DIMENSIONS

WHEELBASE: 120.9 in

LENGTH: 204.3 in

WIDTH: 78.6 in

HEIGHT: 70.7 in

PASSENGER VOLUME:

153 cu ft

CARGO VOLUME:

23 cu ft

CURB WEIGHT: 4680 lb

C/D TEST RESULTS

ZERO TO 60 MPH:

6.5 sec

ZERO TO 100 MPH:

17.3 sec

ZERO TO 120 MPH:

31.7 sec

ROLLING START,

5–60 MPH: 6.8 sec

1/4-MILE: 15.1 sec

@ 94 mph

TOP SPEED: 130 mph

(governor limited)

BRAKING, 70–0 MPH:

176 ft

ROADHOLDING,

300-FT-DIA

SKIDPAD: 0.83 g

FUEL ECONOMY

EPA COMBINED/CITY/

HWY: 20/17/25 mpg

C/D OBSERVED:

21 mpg

Shell
V-Power
NITRO+
Premium Gasoline
The Official Fuel of
CAR AND DRIVER



tech highlight

ENGINE TURNING

The GMC Acadia and Chevrolet Traverse both ride on GM’s new C1XX platform and they’re both fitted with 3.6-liter V-6 engines producing 310 horsepower. But these engines are not the same. The Chevy’s, dubbed LFY, is an evolution of GM’s original “high-feature” V-6, while the LGX in the GMC is the second-generation version of that engine, designed from a clean sheet for the 2016 Cadillacs.

Why produce two very different engines with virtually identical displacement and the same horsepower? It comes down to cost and manufacturing capacity: GM has been building the LFY’s predecessor at its St. Catharines Propulsion Plant in Ontario, Canada, so it is already tooled up and ready to start cranking out the new version. Upgrades to the LFY are centered around redesigned cylinder heads that integrate the exhaust manifolds. Larger intake valves and better-flowing exhaust ports make it breathe easier, and the fuel pump and rails bring NVH improvements. What’s most noticeable in the Traverse, however, is the broad and flat torque band, a result of the revised design, delivering at least 90 percent of the LFY’s 266 pound-feet from 1825 to 6800 rpm.

While the LFY doesn’t have cylinder deactivation like the LGX, a nine-speed transmission with stop-start technology allows the Traverse to earn EPA combined fuel-economy ratings identical to the lighter Acadia’s.



LFY



LGX



TESTED



Space Invader

Toyota's **C-HR** is sci-fi betrayed by ordinariness. *by John Pearley Huffman*

FORGET THE ROBOT DONKEY KONG STYLING: The 2018 Toyota C-HR is the numb spawn of a lazy and predictable automotive culture. It's crossover-like because almost everything is that way today. It's handicapped by a continuously variable transmission that saps it of mechanical engagement and saddles it with an irritating drone. It's underpowered, its handling is uninspiring, and it's not that roomy. This is Toyota not trying hard.

Built atop the Toyota New Global Architecture that underpins the new Prius and Camry, the C-HR uses struts in front while an independent multilink arrangement holds up the tail. The C-HR almost replaces the larger Venza and the smaller Scion xD, with a call back to the forgotten Matrix. It's Toyota's version of the dead-for-2018 Nissan Juke, but with 4.3 inches more wheelbase and an 8.8-inch-greater overall length. The two share crouching-chimpanzee profiles and high-mounted rear-door handles.

But while the Juke was offered with all-wheel drive and a turbo engine, the C-HR isn't. Its engine is modest—a 2.0-liter four with variable valve lift rated at 144 horsepower at 6100 rpm. The torque peak comes at a reasonable 3900 rpm, but there's only 139 pound-feet to be had. Modesty isn't a virtue with CVTs. They tend to operate best when lashed to a modern turbo engine with a torque curve that starts down low and sticks around. The 188-hp turbocharged 1.6-liter engine used in the outgoing Juke, for instance, produces 177 pound-feet at 1600 rpm and sustains that to 5200 rpm. The transmission doesn't need to hunt for grunt; it's always there.

There is some fun in the virtual gears programmed into the C-HR's transmission, but there are no paddles to trigger those pseudo shifts. And 144 horsepower up against 3286 pounds means the C-HR lugs to 60 mph in 11.0 seconds and completes the quarter-mile in 18.4 seconds at 79 mph. Beyond that, a lack of responsiveness in passing adds terror to the mix. It



[+] Stylish and supportive front seats, it's a motor vehicle.
[-] A slow and droning machine hobbled by its own transmission.

takes the C-HR a lethargic 7.5 seconds to groan from 50 to 70 mph. The CVT murders any sense of fun in the C-HR.

All C-HRs wear 18-inch wheels inside 225/50R-18 all-season tires. The steering is light, competently relating an uninteresting story. Lateral adhesion comes in at 0.81 g with predictable understeer.

Toyota sells the C-HR in two trim levels: the \$23,545 XLE and the \$25,395 XLE Premium. The XLE feature list includes projector-beam headlights, dual-zone automatic climate control, adaptive cruise control, leather on the steering wheel and shift knob, and a 7.0-inch central touchscreen. The XLE Premium adds illumination for the visors' vanity mirrors, blind-spot monitoring, heated cloth seats, and puddle lights in the side-view mirrors that project the C-HR logo onto the ground.

But Android Auto, Apple CarPlay, and Toyota's Entune audio suite are all missing. And the backup camera's picture is displayed in a little square embedded in the rearview mirror instead of on the center screen. Navigation system? Does AAA still offer free maps?

The C-HR's cabin is nicely detailed in satin black, but it isn't expansive. The front seats are supportive, but passengers squeezed in back may knock noggins getting in under the sloping rear roof.

But the C-HR's most serious problem is bigger than its lack of features, its packaging, or even its absent power and handling. It's all those things combined: This brand-new Toyota isn't as good as a seven-year-old Nissan that's dying next year.

2018 TOYOTA C-HR XLE PREMIUM

VEHICLE TYPE: front-engine, front-wheel-drive, 5-passenger, 4-door hatchback
PRICE AS TESTED: \$25,589
BASE PRICE: \$25,395
ENGINE TYPE: DOHC 16-valve inline-4, aluminum block and head, port fuel injection
DISPLACEMENT: 121 cu in, 1987 cc
POWER: 144 hp @ 6100 rpm
TORQUE: 139 lb-ft @ 3900 rpm
TRANSMISSION: continuously variable automatic with manual shifting mode
DIMENSIONS
WHEELBASE: 103.9 in
LENGTH: 171.2 in
WIDTH: 70.7 in
HEIGHT: 61.6 in
PASSENGER VOLUME: 84 cu ft
CARGO VOLUME: 19 cu ft
CURB WEIGHT: 3286 lb

C/D TEST RESULTS

ZERO TO 60 MPH: 11.0 sec
ZERO TO 100 MPH: 33.8 sec
ZERO TO 110 MPH: 48.6 sec
ROLLING START, 5-60 MPH: 11.8 sec
1/4-MILE: 18.4 sec @ 79 mph
TOP SPEED: 115 mph (drag limited)
BRAKING, 70-0 MPH: 174 ft
ROADHOLDING, 300-FT-DIA SKIDPAD: 0.81 g
FUEL ECONOMY
EPA COMBINED/CITY/HWY: 29/27/31 mpg
C/D OBSERVED: 28 mpg

Shell
V-Power
NITRO+
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Aging Bull

The world's highest-mileage Lamborghini, this **Murciélago** makes us swoon and swear. *by Mike Duff*

▼ **WHILE WE'VE DRIVEN AND RIDDEN** in 250,000-mile cars before, most felt a breath away from the junkyard, worth no more than their weight in scrap. Not this one, though. From a range of 10 feet, this United Kingdom-registered Lamborghini Murciélago could pass for a pampered garage queen.

It's only when one moves closer that, as with an aging Hollywood A-lister, its age spots become visible. The "V12 6.2L" badge that sits on the rear flank is heavily marred, and opening the driver's scissor door reveals that the embossed "MURCIÉLAGO" plastic sill protector has been replaced recently, the old one worn away by the thousands of backsides that slid over it. But the most telling detail is the fuel-filler release button, its pump decal scratched to near oblivion by the number of times it's been pressed. It's hardly surprising given the car's combined fuel-economy average of 10 mpg, all of it on the U.K.'s pricey super unleaded.

The world's highest-mileage Lambo has led a hard life, but a full one. It belongs to Simon George, a Brit who acted impulsively on his desire to own one of Sant'Agata's finest by financing this then-new 2004 model 13 years ago, then realized he couldn't afford to make the monthly payments. So he sent it out to earn its keep working for a supercar-experience company. George later branched out to co-found his own, called 6th Gear Experience, where the Murciélago became the pride of the fleet. It acquired most of its mileage as a hardworking demonstrator and while traveling between events.

The odometer's unlikely 258,116-mile tally could have been higher by now; the Murciélago narrowly survived a crash during an event in late 2012, which bent its chassis. Rebuilding it took \$117,000 and nearly four years. Now retired from front-

line duties, it has become George's daily driver, frequently used for his 180-mile commute. He's planning a trip back to the Lamborghini factory soon. But before that, we get a turn.

The Murciélago's cabin bears much more wear than its freshly repainted exterior; some bits of trim are missing, and the fold-down storage compartment in the roof is held shut by tape. But apart from a check-engine light—the one thing we bet this Lambo has in common with most every other quarter-million-mile car on the planet—its power seems barely diminished. The huge V-12 yowls and barks, its performance serious enough to stimulate our recall of Italian expletives. The combination of winter tires and British rain limits traction in a sometimes thrilling, sometimes terrifying fashion, but there's none of the sensation of sloppiness normally associated with starship mileage. Although the steering is slow by current standards, it feels noticeably nicer than more recent Lambos, and the open-gated manual gear-shifter feels as solid as ever.

Taking a Lamborghini this far hasn't been cheap—it's had more than 80 sets of tires and eight new clutches, plus three full engine rebuilds. We reckon the total, including fuel and depreciation, is between \$650,000 and \$820,000 at current exchange rates. Worth every penny, we're sure you'll agree. ■

[+] Perfect Italian patina, V-12 nostalgia, gated shifter.
[-] Italian patina is still patina, could have bought a Tuscan Villa.

2002 LAMBORGHINI MURCIÉLAGO*

VEHICLE TYPE: mid-engine, all-wheel-drive, 2-passenger, 2-door coupe
PRICE AS TESTED: \$283,600
BASE PRICE: \$281,100
ENGINE TYPE: DOHC 48-valve V-12, aluminum block and heads, port fuel injection
DISPLACEMENT: 378 cu in, 6192 cc
POWER: 572 hp @ 7500 rpm
TORQUE: 479 lb-ft @ 5400 rpm
TRANSMISSION: 6-speed manual
DIMENSIONS
WHEELBASE: 104.9 in
LENGTH: 180.3 in
WIDTH: 80.5 in
HEIGHT: 44.7 in
PASSENGER VOLUME: 49 cu ft
TRUNK VOLUME: 6 cu ft
CURB WEIGHT: 4058 lb

C/D TEST RESULTS

ZERO TO 60 MPH: 3.8 sec
ZERO TO 100 MPH: 9.5 sec
ZERO TO 160 MPH: 27.2 sec
ROLLING START, 5-60 MPH: 4.8 sec
1/4-MILE: 12.6 sec @ 116 mph
TOP SPEED: 205 mph (drag limited, mfr's claim)
BRAKING, 70-0 MPH: 155 ft
ROADHOLDING, 300-FT-DIA SKIDPAD: 0.98 g
FUEL ECONOMY
EPA COMBINED/CITY/HWY: 10/8/12 mpg
C/D OBSERVED: 10 mpg

*Specs and results, July 2003.

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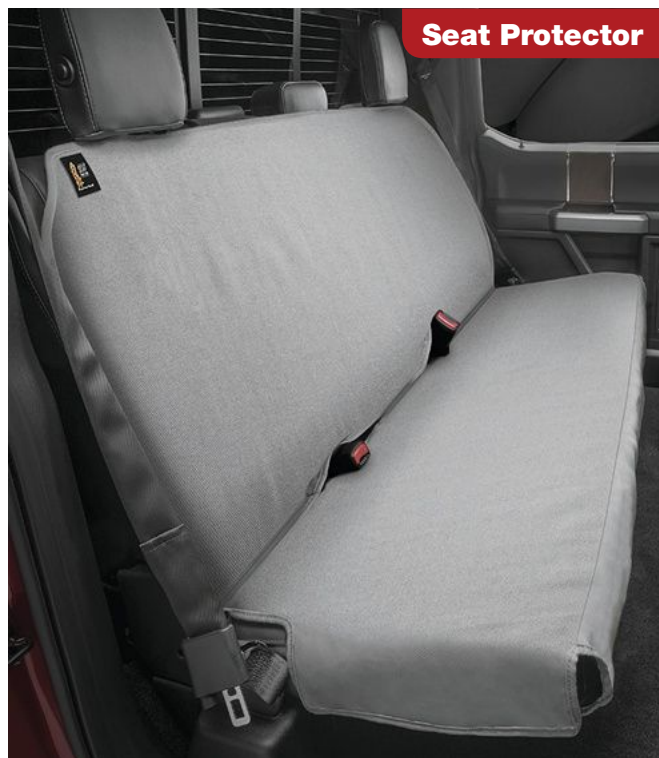
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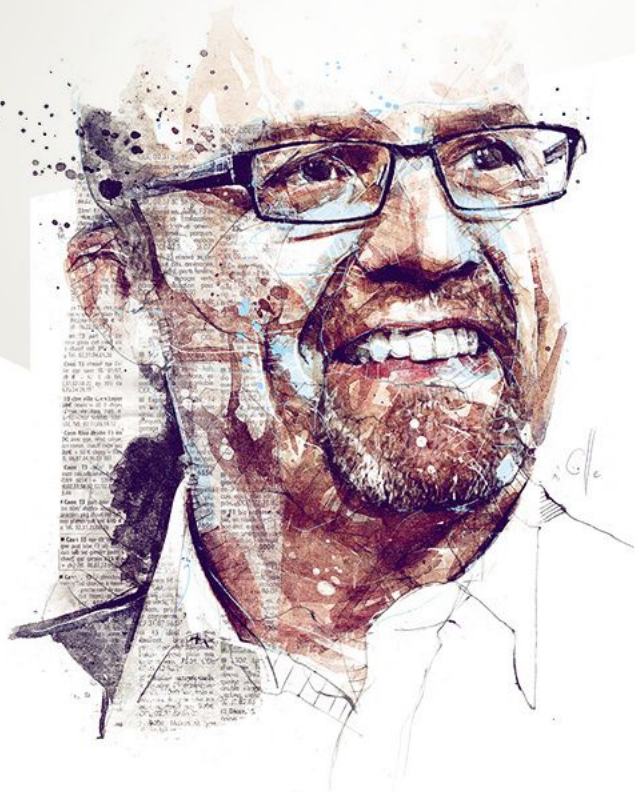
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What I'd Do Differently

Kyle Petty, 57

Grandson of Lee, son of Richard, father of Adam, Kyle Petty is NASCAR royalty. He stopped racing in 2008 but has been talking about it his entire life.

► interview by JOHN PEARLEY HUFFMAN



C/D: What's been difficult about being a race broadcaster?

KP: The hardest thing in making that transition was being honest. Just telling how you feel. My whole world was inside that fence in the infield—what's known as the garage area. All those other drivers, all those other owners, and all those other team members? We talked openly. If somebody did something stupid, we just said it to each other in the garage area. But saying it in the garage area and saying it on a broadcast to millions of people are entirely different things.

■ Is broadcasting as rewarding as driving was?

□ No, nothing is as rewarding as driving. When you're four, five, six, or seven years old, and you decide that that's what you want to be—you want to be a race-car driver—

it's about driving. It's not about doing commercials. It's not about having a big house or an airplane. It's not about any of that. Your dream is to drive. Nothing will ever top what your dream is.

■ What's the secret to a great ponytail?

□ It's all in the scrunchie.

■ Did you ever feel as if the fans wanted to kill you?

□ I've felt that they wanted to fight but not that they wanted to kill me. I was dang sure they wanted to fight.

■ Is the championship over-rated? Don't fans really only care about the races?

□ I never thought about it in those terms until last year when Jimmie Johnson was going for seven, and my dad said, "You know, in all the years that I raced, there was only one year that, when it got down to

it, we raced for a championship." And that was between him and Darrell Waltrip [in 1979]. "All the other years, we just tried to go and win as many races as we could. And if we won all the races, we won the championship." So, in his mind, winning races was the bigger deal. The championship was a byproduct of winning races. Now it's almost the reverse. People race to win championships. I don't think he can wrap his head around that.

■ Is that one reason why NASCAR is shrinking now?

□ Maybe that's part of it. But there's no one answer. There are maybe 10 or 15 answers. Is it one-fifteenth of it? I'll probably say yes. It's also one-fifteenth that the races are ample hours long and no millennial's attention span is that long. And it's one-fifteenth that we went through a stage where it grew and grew, and now it's found its level again. This is the base we have to build off. There are so many factors that go into it.

■ Is it different today for young drivers than when you raced?

□ Yes. And let me tell you something: I would hope to God it was different. When I started, that was a totally different world than when Richard Petty and David Pearson and Cale Yarborough and Benny Parsons were racing. It's a totally different car, it's a totally different time. It constantly moves.

■ Did you have a favorite race car?

□ A car was never really a car. A car was a collection of a lot of different pieces that came together. One week, that collection is one group of pieces, but the next week, it is a totally different group of pieces. I never had an emotional attachment to anything mechanical like that.

■ Your son Adam died while practicing at New Hampshire in 2000. Does that make you resent racing?

□ No. And this is from the bottom of my heart. This goes back to Level Cross, North Carolina. Most of the people in the community I grew up in—and it wasn't even a town, just a ballpark and a volunteer fire department and one gas station and everybody talks. When I grew up there, they were tobacco farmers, dairy farmers, hog farmers, and chicken farmers. That's all anybody

did. I went to school with kids who became third- or fourth-generation farmers. We just happened to have race cars. When I came along, I was a third-generation race-car driver, and that's what we did. We grew race cars. And that [living] was incredibly generous to my grandfather, and a great way for him to provide for his family. My dad came along and did things no other driver had ever done. I came along and followed in those footsteps. Then along comes Adam. And accidents happen. So you look at it and ask, "What do we do now?" And we do what we've always done. Just like the local farmers. When a bad year comes along and a crop fails or something tragic happens on the farm, you don't stop farming. And we didn't stop racing. It changed our business, and it changed my life—the trajectory of what I would've been or could've been and where I was headed at that time. I love this sport, my dad loves this sport, and my granddad did. And nobody had a love for it like Adam had for it.

■ Is there anything you would have done differently?

□ Every day I've had except one has been a good day. I'd like to change that day, but I'd still want it all to lead to where I am now. ■

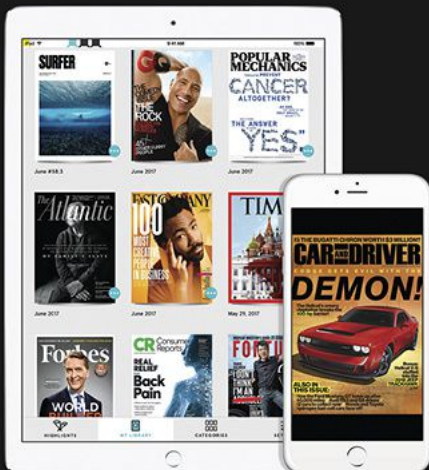
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